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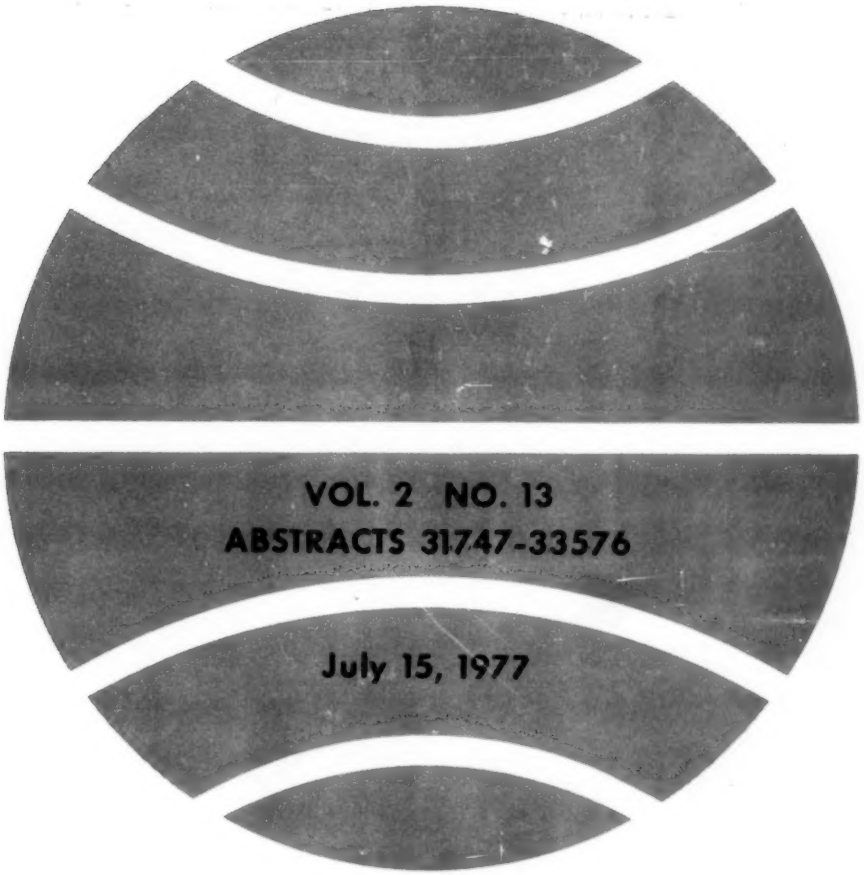

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Volume 2, Number 13, July 15, 1977

ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 32704

PROCESSING

REFER ALSO TO CITATION(S) 32060

CARBONIZATION

REFER ALSO TO CITATION(S) 31758

31747 Agglomerated coke from non-caking slacks using fluid-bed carbonization technique. Basu, S.K.; Mazumdar, P.K.; Chatterjee, P.; Roy, L.C.; Chakravarti, A.K. (Central Fuel Research Inst., Dhanbad, India). *J. Inst. Eng. (India), Chem. Eng. Div.;* **56**: No. 3, 111-113(Jun 1976).

The nature and quantity of products obtained by fluid-bed carbonization of several non-caking coal slacks are given, and some typical results on the preparation of synthetic agglomerated coke utilizing the products obtained are presented.

DESULFURIZATION AND PURIFICATION

31748 Thermal dewatering of brown coal. Verschuur, E.; Ter Meulen, B.P.; Van Herwijnen, T.; Boom, J. (to Shell Oil Co.). US Patent 3,992,784. 23 Nov 1976. Filed date 11 Jun 1975. 8p.

The invention relates to a process for the upgrading of solid material containing bound water and free or chemically bound carbon, in particular brown coal, which process involves a heat treatment at a temperature of at least 150°C and at a pressure that is higher than the vapor pressure of water at that temperature. 15 claims, 3 figures.

31749 Removal of mineral matter including pyrite from coal. Reggel, L.; Raymond, R.; Blaustein, B.D. (to Secretary of the Interior). US Patent 3,993,455. 23 Nov 1976. Filed date 25 Jun 1973. 4p.

Mineral matter, including pyrite, is removed from coal by treatment of the coal with aqueous alkali at a temperature of about 175 to 350°C, followed by acidification with strong acid. 3 claims.

31750 Process for desulfurizing pipeline coal. Cole, E.L.; McMahon, M.A. (to Texaco Inc.). US Patent 3,993,456. 23 Nov 1976. Filed date 24 Feb 1975. 4p.

Disclosed is a process for reducing the pyritic content of coal while a coal-water slurry is transported in a pipeline by injecting a pyrite oxidant into the pipeline upstream of the dewatering plant associated therewith. 6 claims, 1 figure.

31751 Coal beneficiation. Iannicelli, J. US Patent 3,999,958. 28 Dec 1976. Filed date 14 Aug 1974. 10p.

Particular readily separable particulate sulfur-reactive scavenging materials are heated with sulfur-containing particulate coal to extract sulfur from that coal. Reacted portions of the particulate scavenging material are then separated from the particles of coal, using a separating force effective on the scavenging material and which serves to also separate the reacted portions of the scavenging materials. 5 claims, 5 figures.

HYDROGENATION

31752 Process for continuous catalytic hydrogenation. Zucker, F.J. (to Hans Heinrich Auer). US Patent 3,988,329. 26 Oct 1976. Priority date 21 Dec 1973, German, Federal Republic of (F.R. Germany). 8p.

A process for the continuous catalytic hydrogenation of materials in a flowable form is described. In the process the material to be hydrogenated and a hydrogenating agent in the presence of a hydrogenation catalyst are subjected to shearing forces and a rapid succession of compressions and expansions. Prefereably, the shearing forces and rapid succession of compressions and expansions are provided by means of a row of teeth in the reaction zone which move at a small spacing from one another. The process provides a higher reaction rate for a select catalyst and, additionally, permits the continuous use of the catalyst-without detrimental affects. 9 claims, 4 figures.

GASIFICATION

REFER ALSO TO CITATION(S) 31785, 32836

31753 Status of the OCR/A.G.A. coal gasification program. Detman, R.F. (C.F. Braun and Co., Alhambra, CA). pp 11p., Session IV, Paper 3 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

The joint Government-Industry research program for developing new coal gasification processes was begun in 1971. It is an accelerated program to carry previous bench scale research into the pilot plant stage over a four-year period. Some five processes are involved, two of which are in the pilot stage; the others are in design or construction. A brief description of the salient features of each process is given, along with its current stage of development. Other activities in the program are also described, such as research and pilot unit testing of various new schemes for methanating the raw gas produced by the gasifiers, and the testing of American caking and swelling coals in a modified Lurgi gasifier at Westfield, Scotland.

31754 (FE—2317-3) Thermal effects during material conversion and catalytic processes. Quarterly report, October—December 1976. Low, M.J.D. (New York Univ., N.Y. (USA). Dept. of Chemistry). Jan 1977. Contract EX-76-S-01-2317. 2p. Dep. NTIS $3.50.

The project is concerned with making radiometric measurements of the temperature of catalyst surfaces under varying conditions. The project is in the "starting-up" phase; the work has been mainly concerned with the construction of measuring systems but halted because of staffing problems.

31755 Outlook for underground coal gasification. Schrider, L.A.; Brandenburg, C.F.; Fischer, D.D.; Boyd, R.M.; Campbell, G.G. (Energy Research and Development Administration, Laramie, WY). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 9, 409-415(Sep 1976).

Past experiments have shown underground coal gasification (UCG) to be technically feasible but not economically competitive. During these tests, stabilization of gas production rates and of gas heating value were not achieved for sustained periods. The Bureau of Mines began UCG experiments at Hanna, Wyoming, in November 1972. In January 1975, this work was transferred to the U. S. Energy Research and Development Administration. The problems of past tests have been avoided and encouraging results have been obtained. No gas leakage from the reaction zone has been observed. Gas production rate and gas heating value were relatively stable for a 5½ month period approximately 20 tons of moisture-free coal were gasified per day, energy balance calculations showed 3.5 times more energy produced than consumed, and comparison with an airblown surface gasifier showed similar energy recovery efficien-

cies. A second experiment to further define process feasibility is underway. If results from this experiment are favorable, design and construction of a 15 to 30 MWe pilot plant will follow. Successful pilot plant operation would lead to design of a commercial demonstration plant by 1980.

31756 Process for the continuous hydrocarbonization of coal. Albright, C.W.; Davis, H.G. (to Union Carbide Corp.). US Patent 3,988,236. 26 Oct 1976. Filed date 27 Dec 1974. 34p.

A continuous, hydrocarbonization process is described wherein a dense-phase flow of coal particles is indirectly preheated in the absence of oxygen to a temperature below the temperature at which the coal particles undergo plastic transformation, introduced into the bottom of a vertical fluid-bed reaction zone at a high velocity in a vertically upwards direction and reacted with hydrogen to yield char, liquid and gaseous products. The hydrocarbonization reaction is conducted at a temperature of 480 to 600°C, a hydrogen partial pressure of from about 100 to about 1200 psi and an average solids residence time of 1 to 30 minutes, preferably about 5 to about 60 minutes. A high velocity enables the coal particles entering the reaction zone to rapidly and uniformly distribute themselves at their preheated temperature within a matrix of nonagglomerating particles within the reaction zone, thus preventing agglomeration of the coal particles in the fluid-bed reaction zone. 20 claims, 2 figures.

31757 Integrated coal hydrocarbonization and gasification of char. Davis, H.G.; Albright, C.S.; Potter, J.J. Jr.; Strick, C.E. (to Union Carbide Corp.). US Patent 3,988,237. 26 Oct 1976. Filed date 27 Dec 1974. 14p.

An integrated continuous process is described for the production of liquid and gaseous fuels wherein coal particles are hydrocarbonized with a hydrogen-rich gas supplied by a gasification process employing two separate and interconnected zones for combustion and gasification and wherein char produced by the hydrocarbonization of the coal particles provides the feed for the gasification zone. 14 claims, 1 figure.

31758 Furnace for manufacturing high calorific gas and coke from coal. Pikon, J.; Wasilewski, P.; Mitka, B. (to Politechnika Slaska im Wincentego Pstrowskiego). US Patent 3,988,210. 26 Oct 1976. Filed date 28 Feb 1975. 4p.

A furnace for manufacturing a high-calorific gas and coke from coal, provided with two walls perforated in their upper portion, which form a rectangular chamber filled with a coal charge. These walls are provided with channels with inlet pipes for supplying hot combustion gases and the furnace is furnished in its upper zone with inlet pipes for delivering coal to the furnace and ramming pistons having imparted free reciprocating motions. At the side of the furnace in its upper zone are inlet pipes for supplying a hot circulating gas to the direct heating chamber where a coal charge is directly heated. Inside of the gas chamber of the furnace there is an outlet pipe for withdrawing cold circulating gas to a blower which then becomes successively heated to the required temperature in a heat exchanger. 2 claims, 2 figures.

31759 Methanation catalyst. Slaugh, L.H. (to Shell Oil Co.). US Patent 3,996,256. 7 Dec 1976. Filed date 22 Dec 1975. 6p.

The reaction of hydrogen and carbon oxides (carbon monoxide and carbon dioxide) to form methane at temperatures above 300°C is promoted by carrying out the reaction in the presence of a catalyst containing molybdenum disilicide. 3 claims.

LIQUEFACTION

REFER ALSO TO CITATION(S) 31757

31760 (LBL—5273) **Chromatographic determination of adsorption and diffusion in a bidispersed porous solid.** Boisvert, P.G.; Petersen, E.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1976. Contract W-7405-ENG-48. 114p. Dep. NTIS $5.50.

Thesis.

Mass transfer within a well defined bidispersed solid structurally similar to coal, namely 5A molecular sieves, was studied. It was hoped that such a study would ultimately yield more efficient liquefaction processes by better using the internal surface area in coal. The diffusion and adsorption of nitrogen, argon, and carbon dioxide have been studied using a chromatographic technique. A monodispersed pore model was used to describe the bidispersed pore system of the 5A molecular sieve. This model was an accurate representation of the 5A pore system since negligible mass transfer resistance was measured in the micropores. These studies indicate that much larger solid-adsorbate interactions occur with carbon dioxide than with argon or nitrogen. This may explain the enhanced penetrability of carbon dioxide into the microporous structure of zeolites. This study also cites the higher polarizibility and linear molecular geometry of carbon dioxide as a possible reason of its increased penetrability. Extrapolation of these results to coal suggests that highly polar solvents may exhibit better penetrability into coal due to the higher surface interactions. This should yield more efficient coal liquefaction processes by increasing the amount of internal surface area contacted by the solvent. The results obtained from the chromatographic technique illustrate the merits of this method for investigating mass transfer within bidispersed porous solids that do not exhibit transport resistances within their micropores. Extension of this technique to bidispersed solids which do exhibit mass transfer resistances in their micropores, such as coal and 4A molecular sieves at low temperatures, presents some difficulty, but it is believed that this problem can be overcome by increasing the temperature of the determinations.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 31784

31761 Shaft furnace for thermolytic distillation of hydrocarbon fuel. Nazinin, N.A.; Ananiev, S.; Roox, I.K.; Efimov, V.M. US Patent 3,993,546. 23 Nov 1976. Filed date 2 May 1975. 6p.

A shaft furnace for the thermolytic distillation of solid hydrocarbon fuel comprises a vertically disposed cylindrical casing whose upper part accommodates at least two vertical gratings that divide the casing into a heat carrying distributing chamber, a semi-coking chamber and a vapor-gas mixture chamber with a gasification chamber located underneath the three above mentioned chambers. The lowermost edge of at least one of the gratings is provided with opposing cutouts such that the middle section of the edge is substantially lower than the sides of the edge adjoining the casing. In this manner, the solid fuel is more evenly distributed in the gasification chamber and a more uniform distillation of the fuel is achieved. 6 claims, 10 figures.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 32056

BY-PRODUCTS

REFER ALSO TO CITATION(S) 32196

31762 Development of a binder from LTC tar suitable for the production of formed coke. Banerjee, A.; Sanyal, P.K.; Ganguly, S. (Cent. Fuel Res. Inst., Dhanbad, India). *Indian J. Technol.;* **13**: No. 1, 34-38(Jan 1975).

The following optimum conditions for air blowing of tar are established for converting the whole of LTC tar into a binder suitable for the production of formed coke: temperature, 130°C; rate of air, blowing 4-5 cu/ft/gal/min; $FeCl_3$ catalyst, 2%; and blowing period, 45-60 min. The yield of the product obtained under the optimum conditions is 90 +- 2% and its softening point is 40 +- 2°C. 13 refs.

31763 Active carbon and a method of preparing the same. Chia, T.Y. US Patent 3,996,161. 7 Dec 1976. Priority date 5 Mar 1974, Japan. 10p.

When activated by polar compounds containing nonpolar groups bonded with polar groups, coal powders provide inexpensive suitable active carbon for treatment of waste liquid. 8 claims, no drawings.

PROPERTIES

REFER ALSO TO CITATION(S) 31760, 32894

31764 (FE—5065-1) **Prediction model for compositional changes within a coal from core data. Quarterly report, July—September 1976.** Renton, J.J.; Donaldson, A.C.; Ting, F.T.C. (West Virginia Univ., Morgantown (USA)). 1976. Contract E(40-1)-5065. 21p. Dep. NTIS $3.50.

The Waynesburg coal has been sampled on a within-a-mine basis with 22 sections each with the coal sampled at 6-in. increments excluding partings for a total of 314 samples. In addition, two grid samplings were taken on the top of the bottom bench of 30 samples each; one grid on a 1-meter grid interval and the other on a 3-meter grid interval. All samples are subjected to moisture, volatiles, high-temperature ash, BTU, sulfur (total and species), and low-temperature ash (LTA) determinations. The LTA were analyzed by x-ray diffraction. In addition, 99 lithotype samples were collected; 44 from regional locations and 55 from a single column location. These samples, in addition to petrographic descriptions both megascopic and microscopic, were subjected to the basic analyses listed above. A systematic study of pyrite in the Waynesburg coal was initiated with an optical microscopic and a scanning electric microscopic description of pyrite in LTA, whole coal samples, lithotypes and

macerals. A classification scheme for the description of pyrite types was evaluated. The application of a combined pyrolytic-chromatographic technique was used to analyze the basic organic makeup of whole coal, lithotype and maceral samples. These data will be correlated with the previous petrographic and inorganic data.

31765 Some natural products from two soft coals. Their removal, metal-binding, and enzyme inhibitory activity. Kober, T.E.; Sorenson, J.R.J.; Menden, E.E.; Petering, H.G. (Univ. of Cincinnati). *Arch. Environ. Health;* **31**: No. 4, 182-188(1976).

The chemical constituents of coal have not been fully characterized in relation to the incidence of coal workers' pneumoconiosis (CWP). In this study two soft coals obtained from mines in which workers had high and low incidences of CWP were leached with aqueous base and acid to remove their acidic and basic components. The results suggest that humic substances similar to those found in soil are present in the coal samples. Further, differences in the quantity of material removed and its metal-binding and enzyme inhibitory activity are related to disease incidence.

WASTE MANAGEMENT

31766 (EPRI-AF—294) **Reaction of silicon carbide with fused coal ash. Final report.** Perkins, R.A.; Lavendel, H.W. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). Nov 1976. 64p. Dep. NTIS $4.50.

The reaction of two grades of commercial silicon carbide (Carborundum KT and Super KT) with fused coal ash slags (acid and basic) in a synthetic coal combustion atmosphere have been studied. Computer calculations of chemical equilibria predicted a thermodynamic instability of the carbide in this environment. However, experimentally observed reaction rates were found to be exceedingly slow in either acid or basic ash slags. Both grades of silicon carbide were found to have equally good long term resistance of the SiC phase to corrosive attack by either sintered or fused ash at temperatures to 1250°C (basic ash) and 1450°C (acid ash). Super KT silicon carbode suffered extensive loss of free silicon from the entire outside surface of tubes exposed to both acid and basic ash slags in short times (less than 50 hr.). The effect was most pronounced in acid slags at temperatures above 1250°C. The KT grade of SiC was much more resistant to this form of attack and suffered only a superficial loss of silicon in random locations. The loss of silicon occurs by the reaction of excess (free) silicon in the carbide body with particles of metallic iron in the slag to form low melting silicides and eutectics. Free iron is generated by the reduction of iron oxide in the fused coal ash slags on contact with silicon and silicon carbide. The attack can be minimized by limiting the service temperature to 1200°C maximum and burning coals with a basic ash low in oxides of iron. In addition, silicon carbide grades such as KT in which the free silicon is not present is an interconnected matrix phase will have the best resistance to this form of selective attack.

31767 (EPRI-FP—272(Vol.1)) **Evaluation of regenerable flue gas desulfurization processes. Volume I. Final report.** Aul, E.F. Jr.; Delleney, R.D.; Brown, G.D.; Page, G.C.; Stuebner, D.O. (Radian Corp., Austin, Tex. (USA)). 30 Jul 1976. 113p. Dep. NTIS $5.50.

Eleven regenerable flue gas desulfurization (FGD) processes have been evaluated on a common design and cost basis to assess their future potential and make recommendations regarding the level of additional developmental activities. One throwaway FGD process, lime/limestone wet scrubbing, was also considered to provide a base-line for process comparisons. Because of the preliminary development status of many of the processes, capital investment costs were not estimated in this study. Additional topics considered in the study were reducing gas production, lime/limestone sludge regeneration, and sulfur versus sulfuric acid production. Four major conclusions can be drawn from this study. First, although capital costs were not estimated during this study, it is clear that they will represent a major factor in the total annualized cost of these processes and will become the key to selecting one process over another. Second, designs and operating data currently available for most second-generation FGD processes do not appear adequate for scale-up to commercial sized (100 MW) units. Third, the choice of sulfur or sulfuric acid production is a criterion which will have a major impact on the cost of an FGD system and will have to be evaluated on a site-specific basis. Finally, the use of reducing gas produced from coal or heavy fuel oil results in technical and economic penalties when compared to the use of methane as a reductant.

31768 (EPRI-FP—272(Vol.2)) **Evaluation of regenerable flue gas desulfurization processes. Volume II. Final report.** Aul, E.F. Jr.; Delleney, R.D.; Brown, G.D.; Page, G.C.; Stuebner, D.O. (Radian Corp., Austin, Tex. (USA)). 30 Jul 1976. 516p. Dep. NTIS $12.75.

Detailed process descriptions and technical evaluations are given for the following twelve flue-gas desulfurization processes: (1) Westvaco Activated Carbon Process, (2) Shell/UOP Copper Oxide Adsorption Process, (3) Bergbau-Forschung/Foster Wheeler Dry Adsorption Process, (4) Atomics International Aqueous Carbonate Process, (5) Catalytic/IFP Ammonia Scrubbing Process, (6) Citrate/Phosphate Buffered Absorption Process, (7) Ammonia—Ammonium Bisulfate (ABS) Process, (8) Ionics Electrolytic Regeneration Process, (9) Wellman-Lord Sulfite Scrubbing Process, (10) Cat-Ox Catalytic Oxidation Process, (11) Magnesia Slurry Scrubbing Process and (12) Lime/Limestone Wet Scrubbing Process. Since several of the processes require an H_2/CO reducing gas, a section includes various technical and economic considerations relating to four methods of H_2/CO production: steam methane reforming, steam-naphtha reforming, coal gasification, and partial oxidation. The study basis specified that the processes be designed for sulfur production. However, it was felt that recent developments indicate a strong potential market for sulfuric acid exists in some areas which may result in sulfuric acid being the desired by-product although more difficult to store and ship. Therefore, a section discussing sulfur and sulfuric acid production was prepared. Technical and economic evaluation of calcium sulfite/sulfate regeneration for the Lime/Limestone Process is presented.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 33128, 33144, 33155, 33156, 33157, 33158, 33160

31769 Six decades of industrial water treatment (1915-1975). Maguire, J.J. (Betz Labs., Inc., Trevose, PA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 65-69(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

An extensive account of water treatment beginning with the internal treatment of boiler water used for steam generation in the teens to the later treatment of cooling water and industrial process water. In the teens external softening of boiler makeup water was recommended by various processes. In the twenties water problems intensified and research on boiler water scaling began and continued through the thirties. The mechanism of scale formation was studied, and a new Navy boiler compound was adopted. Langelier's Saturation Index work in 1936 served as a basis for early control of scaling by cooling water. In the forties other controls and removers were recommended, and antifoam patents issued. In 1950 Berk proved nitrate an effective inhibitor, and in 1951 influence of boiler design and operation on steam contamination was presented. Internal chemical treatment programs continued to be refined in the sixties with synthetic dispersing agents, and Chelant treatments continued to dominate the seventies, with inspection times extended 2-3 years by their use. Besides treatment of industrial waters, evaluation of results also demanded attention and water quality standards were of concern. Research continues to develop more effective synthetic and naturally-occurring organic agents.

RESERVES AND EXPLORATION

31770 Genesis and oxidation of the iron sulfide in the overburden of Rhenish soft coal. Brinkmann, K. (Univ., Cologne). *Braunkohle;* **12**: No. 28, 448-457(Dec 1976). (In German).

By taking the Frechen opencast mine (in the Rhenish soft coal field) as an example, an effort is made to clarify the genesis of the stratiform iron sulfide mineralisation (marcasite and pyrite) in the hanging bed layers of the coal seams. The Frechen findings have been checked against further tertiary exposures. These indicate the possibility of determining the inden or Fischback layers to the main gravel range by means of geochemical differences in the facies in the case of soft coal mining operations. The ground water or rain water from the Southern Lower Rhenish bay can be probably considered as the "sulfur" supplier. This water transported the sulphide, sulphation and carbon particles which originated from the almost completely eroded groups of upper seams and the partly exploited main seams. The mineralization followed in the Rotton period and was sealed with clay sedimentation. After the removal of the main gravel range and the resulting clearance of the clay to the upper block, the iron sulfide exposed above the ground water level has oxidized. This oxidation has caused partial bleaching of the rock.

MINING

REFER ALSO TO CITATION(S) 31786, 31852

31771 (OEA—76-1) **Surface coal mining in the Northern Great Plains of the western United States: an introduction and inventory**

utilizing aerial photography collected in 1974 and 1975. Hardaway, J.E. (Environmental Protection Agency, Denver, Colo. (USA)). Jun 1976. 180p. Environmental Protection Agency, Denver, CO.

Color aerial photography collected in 1974 and 1975 is presented to portray 21 surface coal mines and one surface uranium mine located in the Northern Great Plains Coal Province of Montana, North Dakota, and Wyoming. Geologic, hydrologic, engineering, operational, and other data are also presented. Through a brief description of surface coal-mining operations, the uses of aerial photography, both color and color infrared, are introduced as tools for planning and regulating surface coal mining and secondary impacts thereof. A brief synopsis and example of a related effort involving satellite imagery is provided. The report provides a basis for planning and assessing surface mining of minerals in the interior western states.

31772 Mining: statutory and certification requirements. Hill, B. pp 16-20 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

The introduction of CENELEC Standards will result in changes in construction and testing for these types of equipment for which there is an existing British Standard. Arrangements will have to provide for equipment to present standards to continue to be used in UK mines as was done in the comparatively recent change in the flameproof standard. The major legal requirements for the use of electricity at mines are under review and other regulations may need amendment to cater for the changes referred to above. Where there is a regulatory requirement for a specific type of protection the regulations will have to be framed so as to allow the use of any equipment certified and tested by any country party to the appropriate European directive. The one regulation which specifies the use of flameproof or intrinsically safe equipment requires the equipment to be so certified by the Health and Safety Executive and amendment of this regulation will be a necessity. The degree of cooperation which is developing between technical experts from EEC and other CENELEC countries in Directives and standards work and in the Electricity Working Party of the Mines Safety and Health Commission should ensure that the difficulties referred to are of no more than a transient nature.

31773 Progress in the design of intrinsically safe power supplies. Thurlow, R.; Green, P.J. (John Davis and Son, Derby, Eng.). pp 32-37 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

The requirement for intrinsically safe power supplies for coal mining applications has changed substantially in the last fifteen years. The introduction of solid state electronic systems created a need for regulated and stablized d.c. power supplies to complement the widely used a.c. supply specified by B.S. 1538. In the early 1960's, d.c. power supplies capable of supplying 2A at 15V were certified I.S. to the testing standards then in use. This compared very favorably with the 15V open circuit voltage and 1.6A short circuit current of the B.S. 1538 a.c. supply. The subsequent introduction of a different type of break flash testing machine combined with the use of cadmium electrodes greatly reduced the safe current levels available at the higher end of the range of voltages commonly used. For instance, in order to meet the revised I.S. tests, the short circuit current of the B.S. 1538 transformer had to be reduced from 1.6A to 440mA.

31774 Environmental monitoring in coal mines. Hall, J.R.; Cooper, L.R. pp 169-173 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

Although data transmission systems have been widely used for many years for the remote control of underground conveyors, their application to the environmental monitoring is only recent. Only a few installations are presently in operation so it would be premature to assess the merits and demerits of the system approach adopted. No major problems have been encountered so far, the system approach is very adaptable and it is expected that it will meet future requirements.

31775 High speed ploughing; development and installation trends. Wilson, J.C. (Dollery and Palmer Ltd). *Colliery Guardian;* **223**: No. 7, 248-250(Jul 1975).

Application of method in West Germany assessment shows that more than 100 installations produced daily tonnages between 1,000 and 3,000 tons saleable; 80 units produced between 1,000 and 2,000 tons/day; 20 units between 2,000 and 3,000 tons/day; and two units averaged in excess of 3,000 tons/day. Tables list methods.

31776 Mine illumination standards. Bockosh, G. (Univ. of Pittsburg). *MESA;* **1**: 2-6(1976).

After careful study it was determined that underground mines should be illuminated with a light intensity of 0.06 foot-lamberts (a measurement of light reflected from surfaces in the lighted area). It was concluded that better lighting would improve productivity as well as safety. Experimental illumination systems were then developed and tested in more than 20 mines. A special laboratory was set up for testing illumination systems in simulated mine conditions. As a result new lighting standards were set up and all U.S. coal mines must be in compliance by April 1, 1978. While some lights are stationary, mounting lights on mining equipment is also a necessity. This involves some design problems [mounting so least vulnerable to damage, resistance to mechanical shock, ability to withstand variable voltage and transients, reliability, avoidance of electrical hazards (including sparks)]. Fluorescent, mercury vapor and sodium vapor lights were developed and tested. Much of this work was done with the help of manufacturers and 2 systems have been approved and are in production while others are in development or approved stages. (LTN)

31777 Basic principles of roof bolting. *MESA;* **1**: 21-24(1976).

Today, nearly all coal mines make some use of roof bolts, and for good reason; when bolts are used properly, they make the roof itself competent, while conventional supports merely prop up the strata overhead and do little to prevent the process of roof deterioration. Bolting also has obvious practical advantages. By posing much less of an obstruction than conventional timber supports, bolts help improve ventilation, allow trackless vehicles greater freedom of movement, and are much less likely to become accidentally dislodged. They also require less storage space and are easier to handle. The basic principles of roof bolting, roof bolt types and methods of installation are described. Methods of improving the consistency of the installed tension are discussed.

31778 Telemetric system for testing the stress on steel rope reinforced conveyor belts in continuous operation. Oehmen, H.H. (Technische Univ., Hanover); Sannemann, J. *Braunkohle;* **11**: No. 28, 411-416(Nov 1976). (In German).

Described is a telemetric test method for determining the elongation spread over the width of a steel rope reinforced conveyor belt in continuous operation. To this end special measuring feelers have been developed with which the pure longitudinal elongation of the different steel ropes can be recorded. An efficient functioning telemetric system has been built up to transmit the data from the running belt to a mobile receiver. This system has been tested under practical conditions and permits the storage of measuring data on magnetic tape up to a period of five hours. The evaluation of the recorded data is done by means of a data processing system supported by a coherent computer. This system permits all the required evaluation steps from the reading of the stored measured values in a digital computer to the two dimensional or perspective presentation of the results. A special coder has been developed for computer compatible coding of the measured values stored on the magnetic tape which also allows the required selection of measured values to be called up for the computer. A belt conveyor used in a soft coal opencast mine with a belt width of 2.2 meters and a distance between axles of 260 to 1900 m has been tested by this method under different working conditions and the function of this test method is shown by means of some results.

31779 Building a fill dam in the Rauberweiher mining field of the Bayerische Braunkohlen-Industrie-AG. Liebl, E. *Braunkohle;* **11**: No. 28, 420-425(Nov 1976). (In German).

After the clearing of the opencast mine in the Rauberweiher coal field of the Bayerische Braunkohlen-Industrie-Ag four lakes were laid at different levels as a result of recultivation measures. These lakes were separated by three embankment-type dams made of overburden. After a description of the state of the coal deposits by way of an introduction, the planning behind the landscaping is covered before a description of the two possible types of earth dams. The necessary soil studies and the construction of the earth dam are described.

31780 Transport crawler for moving conveyor belt drive stations. Hager, M.; Hoefels, H. *Braunkohle;* **12**: No. 28, 457-460(Dec 1976). (In German).

The demanded high output from the large opencast mines in the Rhenish coalfields, where exploitation equipment with daily capacities of 200,000 and 240,000 cu meters is employed, calls for the use of belt installations with 3-meter-wide belts. The drive stations of these belt installations have a rating of up to 6 x 1500 kW and a service weight of some 700 tons. A transport crawler has been developed to move these drive stations which are over 40 meters in length. This crawler with a 200 kW Diesel engine is approx. 11

meters in length, 9.5 meters wide and 2.6 meters high. Under the usual ground conditions in opencast mining it can negotiate slopes of up to 1 in 5 with a cross incline of 1 in 10. The travelling speed under load is up to 4 meters/min. in creep gear and up to 12 meters/min. in normal gear.When travelling empty, speeds of up to 25 meters/min. are achieved. The crawler can also be used as traction unit. The construction and operation of this transport crawler are described in detail.

31781 Longwall mining with chain pillar recovery. Simpson, T.L. (to Atlantic Richfield Co.). US Patent 3,999,804. 28 Dec 1976. Filed date 8 Mar 1976. 6p.

In a longwall mining system, a work face extends between parallel sets of multiple head- and tailgate entries, adjacent entries of each set being separated by rows of chain pillars. Lengths of a headgate entry immediately adjacent the longwall panel and the pillar breakthroughs to the next headgate entry are progressively pump packed in advance of the longwall face with a coherent thixotropic roof-supporting material. As the longwall face is mined, a bidirectional shearing machine cuts through the roof supporting material and the chain pillars, which are then removed in a continuous operation. 10 claims, 3 figures.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 31778

31782 Prediction of performance of a brown coal mill system. McIntosh, M.J. (State Electricity Commission of Victoria, Melbourne). *Braunkohle;* **12**: No. 28, 433-448(Dec 1976). (In German).

A semi-empirical technique was developed to predict gas flow in a milling and drying system. The effect of particulates both on the fan characteristic and the system resistance line have been estimated and found to be in qualitative agreement with published data. Because the concentration of particulates in the gas stream of a brown coal mill is low, the fan characteristic is not expected to be significantly altered for operation on coal. Although the system resistance increases with increase in coal feed rate, in practice this is usually small relative to the resistance on gas alone. A family of fan characteristics was derived from the usual non-dimensional characteristic of head and flow to represent the large change in gas density which occurs across the mill. The operating point of the mill when fed with coal can be determined from the usual two-parameter fan characteristic given the operating point on air alone. The head and flow values are assumed to have the same values as for air alone. The concept of an idealized milling and drying system was introduced and from this the independent variables describing the system were defined. Given the drying gas-temperature and composition; raw coal-feed rate and moisture content; exit duct dimensions; and the mill fan characteristic and operating point on air alone; then the exit conditions of gas flow, gas temperature, and product moisture content can be computed.

31783 Investigation leading to the design of a new coal-preparation plant. Arrowsmith, G.H.; Duncan, A.; Manackerman, M. *Mine Quarry;* **5**: No. 12, 47, 49-50, 52(Dec 1976).

This is the first in a series of articles emanating from the Minerals Engineering Society and concerned with the building of a new coal-preparation plant from the initial concepts to the commissioning, regular operation, and management. It deals with the very first considerations from when the new plant is envisaged and ends with how the flow is defined in terms of organizational, economic, and technical considerations.

31784 Briquetting of reactive coal calcinate with high-temperature coke oven pitch. Joseph, R.T. (to FMC Corp.). US Patent 3,996,108. 7 Dec 1976. Filed date 4 Oct 1974. 4p.

In the production of reactive form coke of the sort described in Work et al., U.S. Pat. Nos. 3,140,241, 3,140,242, and 3,184,293, where a low-temperature reactive coal calcinate is mixed with a binder and formed into shapes which are cured in an oxygen-containing atmosphere and then calcined, the use of high-temperature coke oven pitch as binder for the briquettes is made possible by adding to the calcinate, before mixing with the binder, at least about 3.0 percent by weight of water based on the weight of calcinate. 2 claims.

COMBUSTION

REFER ALSO TO CITATION(S) 32279, 32749

31785 Coal reactor. Gold, L. US Patent 4,004,895. 25 Jan 1977. Filed date 29 Apr 1975. 6p.

A vertical shaft furnace having a diameter substantially equal to the height thereof is employed for the clean combustion of coal to convert the coal virtually stoichiometrically to carbon monoxide. After providing a supporting bed of coke in the base of the furnace a mixture of coal and limestone is introduced through the top of the furnace and combustion takes place adjacent a plurality of circumferentially located tuyeres adjacent the top of the coke bed through which a moderate air blast is introduced. The resulting carbon dioxide is completely converted to carbon monoxide as it passes upwardly through the coal and the reducing atmosphere prevents the oxidation of the sulfur in the coal while the decomposed limestone combines with the sulfur to produce sulfur-bearing compounds. These compounds, as well as the ash are removed by the slag so that a substantialy clean combustion of the coal is achieved to provide a fuel gas which can in turn be cleanly combusted in a separate facility for the generation of power. A substantial transfer of heat from the furnace to the separate facility is accomplished by the nitrogen supplied by the air blast. 6 claims, 3 figures.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 32747

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 31765, 31776, 32187

31786 Dust control: new steps to clear the air. *MESA;* **1**: 11-14(1976).

New procedures for the control, monitoring and sampling of dusts in coal mines depend on a special corps of health and safety inspectors to oversee dust control requirements. This involves sampling, monitoring and a technical inspection of the dust control systems. It appears that pneumoconiosis (black lung) can be prevented by keeping dust levels low and permissible concentrations of respirable dust have been set at 2 mg or less per cubic meter of air throughout a miner's average working life of 35 years. (LTN)

31787 Criteria set for ground check monitors. *MESA;* **1**: 15-16(1976).

Electrical ground check monitors for mine equipment are described, with engineering criteria and methods of testing. (LTN)

PETROLEUM

REFER ALSO TO CITATION(S) 31790, 33289

31788 Turbine meters for liquid measurement. LaNasa, P.J. (Daniel Industries, Inc., Houston, TX). pp 336-341 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Basic principles involved in the use of turbine meters are reviewed. Information is included on meter operation, meter construction, meter performance, meter installation, effects of fluid variations, and meter applications. (JRD)

31789 British and American petroleum industries' response to metrication. Jones, P.; Seward, W.N. pp 433-439 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The petroleum sectors of the British and U.S. economies both face the challenge of metrication. Both are committed to metrication and while facilities are similar, there are a number of dissimilar problems and circumstances which result in different approaches to metrication by each country's petroleum industry.

31790 Eighth annual offshore technology conference. Volume II. Dallas; Offshore Technology Conference (1976). 1006p. (CONF-760577—P2).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

Abstracts were prepared for selected papers. (JSR)

31791 Eighth annual offshore technology conference. Volume 1. Dallas; Offshore Technology Conference (1976). 1004p. (CONF-760577—P1).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

The papers presented at the Conference are compiled. Topics discussed include offshore operations of the petroleum industry, marine engineering, oceanography, geophysical survey, and environmental aspects of offshore operations. Abstracts were prepared for selected papers. (JSR)

RESERVES

REFER ALSO TO CITATION(S) 32067, 32744

31792 National Stripper Well Survey. Oklahoma City, OK; Interstate Oil Compact Commission (1975). 12p.

Data are presented for total production, primary reserves (estimated additional oil to be recovered) and secondary reserves for all states having stripper wells. The secondary reserves include (a) amounts to be recovered from the developed areas of current secondary recovery operations, (b) secondary recovery oil estimated to be produced by expanding the areal extent of current operations, and (c) secondary recovery oil estimated to be produced from fields where secondary recovery operations are not under way, but where conditions are considered to be favorable for successful development of secondary recovery projects. The data are presented in tabular form, and state agency records or other source of the data are indicated. (BLM)

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 31820, 31822, 31889, 33195, 33212

31793 Aluminum activation log. Scott, H.D.; Smith, M.P. (Bellaire Research Labs., TX). *Log Anal.;* **14**: No. 5, 3-12(1973).

Using a californium-252 neutron source emitting 10^9 neutrons/second, a continuous Aluminum Activation log has been developed which can be operated at logging speeds of 20 feet per minute. The log has been run in one uncased and four cased wells. Results indicate that the log has good potential for determining the shale content of formations and should overcome the limitations of the Gamma Ray and S.P. logs. Neutron absorbers in the formations such as salt water and boron can affect the log. However, variations in these quantities can be corrected for if a log of SIGMA is available. Gamma rays in the range 1 to 2 MeV from the decay of ^{28}Al are used for the measurement. The use of californium-252 as a neutron source is preferred (instead of PuBe or AmBe) in order to reduce the interfering effect of silicon activation. Analyses of well data showed that aluminum activation is the dominant product with small contributions also occurring from casing activation, calcium activation, and oxygen activation. Further analysis indicated that the measurement of the total gamma-ray spectrum (instead of only the range 1 to 2 MeV) would permit satisfactory aluminum logs with a 1 x 10^8 n/sec ^{252}Cf source, if the logging speed were reduced to 10 feet per minute. The radiation dose rate from this smaller source would be similar to that produced by 0.5 curie ^{137}Cs gamma-ray source and the radiation shield required to transport the source would weigh about 250 pounds.

31794 Modelling pore structure by ^{2}-D and ^{3}-D networks with application to sandstones. Chatzis, I.; Dullien, F.A.L. (Univ. of Waterloo, Ont.). pp 16p., Paper 7607 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

The present investigation is a study of the properties of 2-dimensional (2-D) and 3-D network models of capillary tubes generalized for any pore size distribution. These properties include: (1) the breakthrough condition subject to the step-by-step invasion of a nonwetting phase into an empty (evacuated) 2-D or 3-D network, (2) the accessibility of pores and (3) the "pseudo" dead end pore fractions, characteristic of the fractional amount of the non-conducting penetrated pore volume. Generalized saturation plots for the accessibility of pores and the pseudo dead end pore fractions have been established. It was found that the accessibility of pores and the pseudo dead end pore fractions are determined by (1) the dimensionality of the network, (2) the co-ordination number of the network, and (3) the topology of pore interconnectedness at the microscopic level. The accessibility of pores found in the network analysis of the penetration process into 2-D and 3-D networks has been critically tested by using: (1) the experimentally known mercury porosimetry capillary pressure curves of two sandstone samples of known "complete" pore size distribution and the experimentally determined accessibility functions, and (2) the saturation at breakthrough observed in mercury penetration experiments.

31795 Operation of Orifice Meter chart integrators. Morris, P.C. (Philip Morris Service Co., Tulsa, OK). pp 1-3 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

An electro mechanical type orifice meter chart integrator is described. The description is presented in sections on orifice meter simulation, computer memory, and counters and readout equipment. (JRD)

31796 Some statistical techniques to optimize the search for stratigraphic traps on seismic data. Rice, G.W.; Waters, K.H. pp 445-456 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Stratigraphic trap exploration using seismic data relies on locating significant horizontal changes in a zone of seismic data for relevant parameters. Seismic waveform characteristics and other parameters such as coherence, amplitude, interval P wave and S wave velocity, etc., may be analyzed with multivariate statistical techniques to identify the location of such changes, as well as to provide a mechanism for relating these sequences to known lithologic conditions. The principles described in this paper are illustrated through the use of an onshore field example; however, the same techniques are applicable offshore. In addition to the delineation and characterization of seismic waveform characteristics, procedures are described to compensate for differences in seismic data acquisition and processing. Band width effects are also considered and may be quantified numerically.

31797 Stability of Mississippi Delta sediments as evaluated by analysis of structural features in sediment borings. Roberts, H.H.; Cratsley, D.W.; Whelan, T. III;. pp 9-15 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Numerous failures of manmade structures in the active Mississippi River Delta have initiated various attempts to distinguish stable from unstable areas as well as to determine the effective depth of sediment movement or potential movement. To investigate the sedimentological and geochemical properties of Recent deltaic sediments, four borings were taken from areas ranging from one considered stable (well-stratified and acoustically transparent sediments) to one where a suspected mudflow feature (acoustically amorphous) occurred. By means of x-ray radiography the internal sediment characteristics were analyzed. Results of this analysis were compared with geochemical and geotechnical data to better define the type and depth of sediment deformation.

31798 Marine sediment instability: interaction of hydrodynamic forces and bottom sediments. Suhayda, J.N.; Whelan, T. III; Coleman, J.M.; Booth, J.S.; Garrison, L.E. pp 29-33 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Simultaneous measurements of bottom oscillations and wave characteristics have been made in a study of the interaction of fine-grained sediments and surface waves. Wave staffs, pressure sensors, and an electromagnetic current meter were placed 150 ft from a bottom-emplaced accelerometer package at East Bay, Louisiana. Measurements were made in about 64 ft of water from an oil platform in an area having a fine-grained clay bottom. Sediment core samples were taken to a depth of 180 ft. The accelerometer package consisted of three solid-state accelerometers mounted at right angles, and had a response of 3 v/g. The package was placed about 1 ft below the mudline. The results of the experiments indicate that bottom motions under wave action show well-defined periodic features. Bottom oscillations on the order of 1 in. in amplitude occurred for seas having a significant wave height of about 3 ft and a period of 5 sec. The bottom appears to be undergoing an elastic wave response to bottom pressures, so that the bottom is depressed under a surface wave crest. Comparison of wave height measurements and pressure measurements indicate that bottom pressures are not predicted by linear theory for a rigid bottom. Pressures were larger than predicted by up to 35 percent in many cases.

31799 Analyses for wave induced sea-floor movements. Wright, S.G. pp 41-50 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Procedures are presented for calculating stresses and soil movements produced by seafloor pressures which are generated by ocean waves. The procedures are based on the finite element method and provide a direct means to assess the effects of gravity on wave induced soil movements. Separate procedures are presented for calculating both cyclic and permanent soil movements. A series of analyses are presented using the procedures described with representative data for the site of a wave induced slide in South Pass Block 70 of the Gulf of Mexico. These analyses show that the gravity stresses and deterioration of soil properties under cyclic loads have an important effect on the soil movements. The important parameters required to calculate realistic seafloor movements with the finite element model are identified and additional studies are suggested.

31800 Response of seafloor soils to combined static and cyclic loading. Herrmann, H.G.; Houston, W.N. pp 54-58 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Two deep ocean soils, a hemipelagic organic silt-clay and a calcareous ooze, were subjected to laboratory triaxial tests under environmental temperature and effective stress conditions to determine their response to combined static and cyclic loadings. Up to 300,000 load cycles without stress reversal, similar to those imposed by the anchor or foundation of a structure subjected to water or wave motion, were used. The strength loss due to cyclic loading of the hemipelagic organic silt-clay was extremely small. That of the calcareous ooze was more significant but not as dramatic as is typically the case where stress reversal occurs.

31801 Stability calculations for offshore gravity structures. Lauritzen, R.; Schjetne, K. pp 76-80 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The paper contains a general discussion of bearing capacity stability calculations for offshore gravity structures founded on clay deposits. An alternative to the present methods called the slip surface method is presented and a parameter study is described. Comparison is made with the methods suggested by Brinch Hansen, Janbu, Karal and Meyerhof. The applicability of the different methods is discussed and evaluated.

31802 Occurrences of oil and gas seeps along the Gulf of Alaska. Blasko, D.P. pp 211-218 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Oil seeps on portions of the Alaska Peninsula (Iniskin Peninsula and Puale Bay area) and north central Gulf of Alaska (Katalla area, Cape Yakataga to Yakutat Bay area) were investigated to determine (1) whether previously reported seeps are still active, (2) the characteristics of the seeping hydrocarbons, and most importantly, (3) the amount of bitumen contained in the drainage leaving the seeps and entering the Gulf of Alaska waters. In all, 18 oil seeps, 7 bitumen deposits, and 12 gas seeps were located and sampled. Oil and gas were analyzed using standard distillation and gas analysis methods. The oils ranged from 35.2° API gravity to 14.1° API gravity and had sulfur content (weight percent) ranging from 0.53 to 1.31. Bitumen samples had API gravities from 2.4° to 14.6° and sulfur (weight percent) content from 0.28 and 0.88. Gas samples had specific gravities ranging from 0.577 to 0.883 Btu/cu ft. Caloric value of the gases ranged from 724 to 1,427 Btu/cu ft. A total of 102 samples of water were obtained from seep locations and seep drainages. Water samples associated with the seeps were analyzed by atomic absorption spectrophotometry for ionic content and by solvent extraction for hydrocarbon content. Analyses confirmed that, although the water at the oil seep sites sometimes contained high bitumen content (i.e., 246,000 mg/liter), the amount of hydrocarbons actually reaching the Gulf of Alaska waters from the seeps is minimal (average 0.2 mg/liter).

31803 Use of helium in mineral exploration. Dyck, W. (Geological Survey of Canada, Ottawa). *J. Geochem. Explor.;* **5**: No. 1, 3-20(Mar 1976).

A literature review of the source and occurrence of helium shows that it can, under favorable conditions, lead to the discovery of radioactive ore deposits, oil and gas pools, and fracture zones associated with mineral occurrences. Analytical results show that anomalous helium is present in ground waters and near uranium occurrences and thus can aid in the identification of uranium occurrences or prospective target areas for uranium exploration.

31804 Geothermal investigations in a surface layer, as in the Voyvozh oil—gas deposit. Lakhtionov, M.O.; Rabotnov, V.T.; Kutuzov, O.N.; Spiridonov, V.A. (Moscow Geological Prospecting Inst.). *Int. Geol. Rev.;* **18**: No. 5, 557-559(May 1976).

Translated from Geol. Razvedka; No. 1, 115-118(1975).

Geothermal investigations at shallow depths (3m or more) in the Voyvozh region have shown that measurements at these depths are virtually independent of seasonal temperature variations. A scheme is outlined for carrying out geothermal investigations in shallow boreholes and for collating results obtained from measurements in neighboring profiles. Investigations by this method have shown that the Voyvozh oil-gas deposit in the Komi ASSR contains a gas pool at the base of the Eifelian stage and a gas and oil pool in rocks of the Pashiy horizon. (BLM)

31805 Developing geochemical methods for marine exploration of oil and gas. Bagirov, V.I.; Zor'kin, L.M.; Zubayraev, S.L.; Lopatin, N.V. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). *Int. Geol. Rev.;* **18**: No. 5, 560-562(May 1976).

Translated from Geol. Razvedka; No. 10, 63-65(1974).

Development of methods for geochemical petroleum-exploration and applications of the methods to the deposits on the Continental Shelf in the USSR and abroad are emphasized. Explorations were carried out in the Caspian and Black Seas using coring devices: gravitational, piston, and vibropiston types. The optimum distance between stations in a detailed survey was 0.5 to 1.0 km and was 4 to 5 km during reconnaissance surveys. In the Caspian Sea, chemical prospecting indicated large amounts of methane and its homologs concentrated above the well-known "Neftyanyye Kamni" oil deposit under conditions unfavorable to biogenic gas formation in sands and coquinas possessing minimum absorptive capacity as well as in the nonprospective regions of the Sumgait shelf where fine-grained muds possess great absorptive capacity. Results of geochemical investigations in the western deepwater part and within the southeast shelf of the Black Sea are reported. (BLM)

31806 Diffusion of gases from hydrocarbon deposits. Klimenko, A.A. *Int. Geol. Rev.;* **18**: No. 6, 717-722(Jun 1976).

Translated from Sov. Geol.; No. 9, 135-141(1974).

The diffusion dispersion of hydrocarbon deposits used in oil and gas prospecting is discussed with mathematical equations that are applicable to various types of deposits. The advantages and disadvantages of the method are pointed out. Certain specific restrictions that must be imposed upon the use of the method are delineated. (BLM)

31807 Oil and gas from the North Sea. Part I. Development, results, and prospects. Schuermeyer, G. (Geschaeftsfuehrung der Deminex Deutsche Erdoelversorgungsgesellschaft mbH, Essen). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 9, 391-393(Sep 1976). (In German).

The exploration activities in the North Sea started after the gas field of Groningen in the Netherlands had been discovered. Initial major successes were recorded in the middle of the sixties. The search advanced stepwise to the north. By the middle of 1976 about 830 exploration wells had been drilled. The activities concentrated mainly on the British and Norwegian sector. According to careful estimates about 200 mio t/a of oil may be available for the European market in the early eighties. The chances of finding oil and gas in the northern North Sea and northern Atlantic are considered to be fairly good.

31808 Problems of applied geophysics by the Prepermian exploration in NW Germany. Krey, T. (Prakla-Seismos GmbH, Hanover). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 9, 394-402(Sep 1976). (In German).

After the energy crisis late 1973 exploration for hydrocarbons in Prepermian layers especially in Devonian limestones is of interest in NW-Germany. The paper presented here discusses whether and how the various methods of applied geophysics can contribute to reach this goal. Refraction seismics may find out minimum thicknesses of the Prepermian sediments, while magnetics and electrical resistivity surveys including magnetotellurics have good chances of yielding maximum depths of the cristalline basement. The possibilities of gravity surveys cannot be considered as being very favorable at present. Until quite recently reflection seismics could not penetrate the Permian in most of NW-Germany. But now reflection seismic horizons which are well under the base of Permian can be recognized and mapped in various parts of NW-Germany by applying most modern techniques. These horizons may well be of interest for hydrocarbon exploration. A good knowledge of the Permian and Postpermian cover is necessary for the successful interpretation of gravity and the two types of seismic surveys.

31809 Radioactive logging for determining oil saturation in a reservoir. Neuman, C.H. (to Chevron Research Co.). US Patent 3,993,902. 23 Nov 1976. Filed date 31 Mar 1975. 10p.

A method is disclosed for determining oil saturation in a petroleum reservoir using logging signals indirectly related to the

abundance of carbon nuclei in the reservoir rock. The first step of the invention is to record a log sensitive to the abundance of carbon nuclei after the region surrounding the well bore is caused to have oil saturations representative of the bulk of the reservoir. A purposeful change is then made in the fuel saturations in the region surrounding the well bore by injecting a liquid capable of displacing substantially all of the original fluids. The log is recorded a second time. The displacing fluid is then itself displaced by brine, and a third log is recorded. Oil saturation is then determined from differences between the logs and from known fractional volume carbon contents of the reservoir oil and the first injected liquid. It is not necessary that the log responses be independent of the material in the bore hole, the casing, the casing cement, or the reservoir rock. It is only necessary that changes in oil content cause proportional changes in log response. 7 Claims, 2 Drawing Figures.

31810 Low-cost but accurate radioactive logging for determining gas saturation in a reservior. Neuman, C.H. (to Chevron Research Co.). US Patent 3,993,903. 23 Nov 1976. Filed date 31 Mar 1975. 16p.

A method is disclosed for determining gas saturation in a petroleum reservoir using logging signals indirectly related to the abundances of oxygen and carbon nuclei in the reservoir rock. The first step of the invention is to record first and second logs sensitive to the abundance of oxygen and carbon nuclei, respectively, after the region surrounding the well bore is caused to have fluid saturations representative of the bulk of the reservoir. A purposeful change is then made in the fluid saturations in the region surrounding the well bore by injecting a liquid capable of displacing substantially all of the original fluids. The logs are recorded a second time. The displacing fluid is then itself displaced by brine, and a third suite of logs is recorded. The total fluid and oil saturations are then determined from the differences between respective corresponding logs and from known fractional volume oxygen and carbon contents of the reservoir brine and oil and the first injected liquid. Gas saturation is then calculated from differences between total fluid and oil saturation values. It is not necessary that the log responses be independent of the material in the borehole, the casing, the casing cement, or the reservoir rock. It is only necessary that changes in formation fluids content cause proportional changes in log responses. 7 Claims, 4 Figures.

31811 Low-cost but accurate radioactive logging for determining water saturations in a reservoir. Neuman, C.H. (to Chevron Research Co.). US Patent 3,993,904. 23 Nov 1976. Filed date 31 Mar 1975. 16p.

A method is disclosed for determining water saturation in a petroleum reservoir using logging signals indirectly related to the abundance of oxygen nuclei in the reservoir rock. The first step of the invention is to record a log sensitive to the abundance of oxygen nuclei, after the region surrounding the well bore is caused to have fluid saturations representative of the bulk of the reservoir. A purposeful change is then made in the fluid saturations in the region surrounding the well bore by injecting a liquid capable of displacing substantially all of the original fluids. The log is recorded a second time. The displacing fluid is then itself displaced by brine, and a third log is recorded. Water saturation is then determined from differences between the logs and from known fractional volume oxygen contents of the reservoir brine and the first injected liquid. It is not necessary that the log responses be independent of the material in the borehole, the casing, the casing cement, or the reservoir rock. It is only necessary that changes in formation content cause proportional changes in log responses. 14 Claims, 4 Figures.

31812 Simultaneous thermal neutron decay time and shale compensated chlorine log system. Pitts, R.W. Jr.; Scott, H.D. (to Texaco Inc.). US Patent 4,002,903. 11 Jan 1977. Filed date 7 Mar 1975. 14p.

Earth formations surrounding a well borehole are repetitively bombarded with bursts of high energy neutrons. A radiation detector in a sonde in the borehole senses the gamma rays induced by the capture of thermal neutrons and sends representative signals to the surface. At the surface electronics, the population of thermal neutron capture gamma rays at two separate and distinct times is measured. The macroscopic thermal neutron capture cross section of the formation may be thus determined and logged. Further, two additional single channel energy analyzers, such as from 1.30 to 2.92 MeV and from 3.43 to 10.0 MeV, sense formation capture gamma ray response over a common time interval following each neutron burst. The measurements made in these two additional single channel analyzers are used to distinguish between the presence of salt water and hydrocarbons in the formation, which is also logged.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 31792, 32055, 33063, 33079, 33083

31813 (ERDA—76-155/1) Analysis and assessment of enhanced oil recovery baseline data: summary, conclusions, and recommendations. Final report. (LaRue, Moore and Schafer, Dallas, Tex. (USA)). 1 Oct 1976. Contract EX-76-C-01-2329. 38p. Dep. NTIS $4.00.

The publications and studies reviewed illustrate the wide range of reserve potential that has been considered for enhanced oil recovery (EOR) techniques. Estimates have ranged from an upper limit of approximately 125 billion barrels to a lower limit of approximately 15 billion barrels. Full realization of this enhanced oil recovery potential will not be obtained until vastly improved economics exist. The operators of these oil reservoirs are all justifiably interested in the profits to be obtained by using EOR techniques and the risk that these profits will not be realized. The risk factor to be considered for these EOR projects must include both the economic risk and the technical risk. The economic risk includes the current lack of confidence in the future oil price (i.e., the world market price and U.S. Government regulations that can reduce the market price), potential changes in the taxes imposed on the industry, and other current, planned, and suggested governmental regulations. Technical risk can be related to the possibility of lower total recoveries and/or lower producing rates than initially anticipated. The technical risk still exists for two tertiary processes expected to have a major impact on a national basis, surfactant/polymer flooding and CO_2 miscible flooding. Both the economic risk and the technical risk are today resulting in major delays of EOR projects. In many instances these projects can be postponed without any loss of current or near term future income until the technical risk is reduced and until more confidence is obtained in the items that are included in the economic risk. Once the EOR technology is proven and the projects are relatively risk free from this standpoint, it will be easier to ascertain if the economic criteria will provide enough incentives to commit funds for these large investments.

31814 Hydrodynamic studies of inhomogeneous formations being worked simultaneously. Diyashev, R.N. (Tatar Pet. Inst., USSR). *Neft. Khoz.;* No. 5, 54-58(May 1975). (In Russian).

It was found that during simultaneous working of inhomogeneous formations in the D/sub 1/ horizon of the Romashkinskiy field more than 40% of the perforated formation did not participate in active working. By increasing the pressure at the mouth of the pressurized wells to 200-225 kgf/cm^2 or more, the number of nonworking formations is reduced to 20% of the total number of perforated formations, owing to the incorporation of low-permeabilty formations into the working. This is confirmed by a decrease in the average permeability and the perforated thickness of the working formations.

31815 Results of exploitation of Precarpathian fields by branched horizontal wells. Kiverenko, V.M.; Mikhalevich, V.I. *Neft. Khoz.;* No. 5, 70-72(May 1975). (In Russian).

The results of exploitation of low-permeability oil deposits in the late stage of their working by means of branched horizontal wells are presented, citing the Borislavskiy and Dolinskiy fields in the Precarpathian region as examples. It is shown that the use of branched horizontal wells leads to an increase in the oil output on fields with low-permeability and discontinuous collectors and also greatly reduces the number of wells required for drilling out deposits.

31816 Deep-pump system for simultaneous and separate working of two formations of which the lower one is the more productive. Akhadov, M.S.; Parenskii, G.P. *Neft. Khoz.;* No. 5, 73-75(May 1975). (In Russian).

A pumping system has been developed which ensures the removal of the fluid from the lower, high-pressure formation by an upper, high-efficiency pump and the removal of fluid from the upper, low-pressure formation of a lower positioned low-efficiency pump. In this case the upper, high-efficiency pump, acting on the lower formation, can be lowered to a more shallow depth, since its setting does not depend on the setting of the lower pump, which acts on the upper formation.

31817 Pressure responses from induced hydraulic fractures in adjacent wells within a petroleum reservoir: an experiment. Wilson, J.F. (Union Oil Co. of California, Brea). *J. Pet. Technol.;* 27: 951-953(Aug 1975).

Research is currently in progress at the Morgantown Energy Research Center to determine if preferred fracture directions are regional or relatively localized in particular oil fields. As part of the research program, experiments were conducted to detect the initiation, location propagation, and lateral extent of induced hydraulic fractures in the oil-productive Bradford Third sandstone formation near Bradford, Pa. Quantitative information on fracture orientation and length would allow accurate planning of well patterns to optimize secondary recovery operations and minimize payout time. 6 refs.

31818 Nuclear explosive method for stimulating hydrocarbon production from petroliferous formations. Nordyke, M. (to USAEC). Australian Patent 466,772/B/. 17 Oct 1975. 31p.

Filed 16 Nov 1971, publ. 24 May 1973, priority USA 16 Nov 1970 (89889), copies available from the Commissioner of Patents, Canberra.

Multiple nuclear explosive devices are emplaced and detonated sequentially at spaced locations in a borehole in a petroliferous formation. The explosive size, relation spacings, depths of burial and sequential timing are selected and arranged to minimize and limit seismic surface effects as well as to optimize fracturing of the formation with consequent more economical stimulation of petroleum hydrocarbon production especially in low-permeability reservoirs.

31819 CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976). vp. (CONF-760676—). $20.00.

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

Thirty papers presented at the meeting are included. Separate abstracts were prepared for each.

31820 Reconciling geology and observed reservoir performance in Swan Hills Unit No. 1. Sears, J.R. (Home Oil Co., Ltd., Calgary, Alberta). pp 12p., Paper 7601 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

Oil production in the Swan Hills A and B Pools is taken from the Swan Hills Formation of Beaverhill Lake Group of Devonian Age. The reservoir rock is a carbonate formed in a bioherm. The rock mass is rather complex with at least seven major porous zones having been identified. The field was discovered in 1957 and steady oil production commenced in January, 1959, after a pipeline became available. Swan Hills Unit No. 1 was formed in January, 1963. About 80% of the pool's oil in place and about 40% of the developed area are contained within the unit limits. Water injection commenced in August, 1963. The reservoir description used in the early engineering studies was rather simple and bore scant resemblance to the complex reservoir geology. As the waterflooding operation has become more mature, it has been necessary to use increasingly more complex geologic models in order to reconcile reservoir performance predictions with observed reservoir performance data.

31821 Selective fluid placement improves stimulation results. Ripley, H.E.; Young, F.T. (Halliburton Services Ltd., Calgary, Alberta). pp 8p., Paper 7604 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

Perforation isolation for selective treating and/or production testing is necessary to insure total zone treatment or evaluation. Two new series of downhole tools are now available to the industry so that one foot, or greater, portions of the wellbore can be isolated. All perforations can now receive treatment. The previous method of treating the total interval at one time, where the treating fluid takes the path of least resistance, could leave some perforations untreated. The new tools can be used for washing perforations with acids or surfactants, sand consolidation treatments, using a single fluid or several fluids, and for other treating purposes. Downhole recorders will provide positive indication of segregation or communication. The integral tool systems provide ease of operation and positive operation, resulting in minimum cost to the operator. A retrievable fluid control valve is discussed. This valve allows an operator to limit the hydrostatic pressure exerted on a formation reducing the risk of overtreating low fluid level wells with expensive chemicals or loading the zone with a large volume of flush fluid. Field experience using these assemblies is outlined and several basic procedures are discussed.

31822 Geologic input for enhanced recovery projects: a case study of an Illinois basin field. Harris, D.G. (Exxon Production Research Co., Houston, TX). pp 12p., Paper 7605 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

Detailed reservoir description studies usually precede the selection of an enhanced recovery process and the establishment of operational procedures for a particular field. Considerable attention sometimes must be paid to the rock framework because some recovery processes are very sensitive to changes in physical properties. Reservoir geology studies have several objectives: (1) determining the number and the vertical and lateral limits of reservoir units, (2) establishing the thickness distribution of reservoir units and the occurrence of "shales" in these units, (3) developing the three-dimensional distribution of porosity, permeability, and hydrocarbon saturation properties for each unit, (4) locating areas where various reservoir units are in vertical pressure communication, and (5) providing information on the storage capacity and permeability capacity of the aquifer. Using a pilot test site as an example, a four-step procedure for geologic studies is presented. The four steps are essentially functional in nature: (1) rock description, (2) determination of reservoir continuity ahd geometry, (3) evaluation of reservoir quality, and (4) integration of framework data. Sources for data include cuttings and cores, well logs, core plugs, seismic surveys, well tests, and pressure-production records. Experience gained from outcrop and subsurface studies often guides thedata analysis. This approach to detailed reservoir description is designed to determine the relative influence of depositional and post-depositional processes on reservoir characteristics.

31823 Costs of supply: oil enhanced recovery schemes in Alberta. Watkins, G.C. (Univ. of Calgary, Alberta). pp 8p., Paper 7606 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

This paper investigates the economics of enhanced recovery schemes in Alberta. Lack of data precluded analysis of all 370 schemes in the province. Calculations were confined to the estimation of a long-run supply price (unit costs) for 13 enchanced recovery schemes in Alberta, but these represent about 40% of enhanced recovery reserves. The supply price is defined as the price just sufficient to recoup all relevant investment expenditures, including return on capital and operating costs, over the project life. Thus, the supply price is confined to real costs and excludes transfer payments, such as taxes, royalties and bids. Data for four variables are required: incremental production, incremental operating expenditure, incremental development expenditure and a discount rate. Information on the first three variables was supplied by industry. In 1973 dollars, estimated supply prices by scheme ranged from a low of some $0.25/barrel to a high of $2.35/barrel, at a discount rate of 12%. The average reserve weighted supply price for the ER schemes examined was estimated at $0.83/barrel. Thus, enhanced recovery production of conventional crude oil in Alberta enjoys a substantial economic rent, before application of transfer payments. The results suggest additional recoverable reserves acquired by implementing ER schemes have been significantly cheaper than those resulting fromnew discoveries, given current average finding costs. The analysis provides justification for emphasis on research directed towards recovering a higher fraction of oil-in-place.

31824 Marine production riser: a subsystem of the submerged production system. Gammage, W.E.; Ortloff, J.E.; Teers, M.L.; Caldwell, J.B. pp 45-56 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The Marine Production Riser (MPR) subsystem is designed to transport oil and gas from a Submerged Production System (SPS) to a floating storage vessel and to permanently moor the vessel. The prototype riser to be tested in the Gulf of Mexico includes a pile founded base (installed October, 1974) with piping manifold to connect pipelines to the riser, a remote multiline connector, an articulated multiline riser, a support buoy and a mooring system. Fabrication and land testing of all components are complete. Detailed plans have been developed and the necessary equipment to complete installation of the MPR is on hand or readily available.

31825 Deepwater pipeline connections: a subsystem of the submerged production system. Sinclair, A.R.; Burkhardt, J.A.; Daughtry, A.C. pp 57-68 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

A deep water pipeline connection method has been designed, built, and successfully tested to remotely attach and connect three sets of pipelines in the SPS pilot test. Two attachment methods, a pull-in and a lay-away, were employed to align and attach the subsea pipelines to an ocean floor structure. A remotely controlled tool aligned, connected, and tested the pipeline connections placed there by both attachment methods. These deep water pipeline connections feature the ability to maintain pipeline connections and hydraulically operated, fail-safe isolation valves by using replaceable spool pieces which contain maintenance prone components.

31826 Manipulator maintenance of subsea equipment: a subsystem of the submerged production system. Rullman, J.D.; Burkhardt, J.A.; Childers, T.W.; Tidwell, D.R.; Merryman, J.E. pp 69-82 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The Maintenance Manipulator System (MMS), a working subsystem of Exxon's Submerged Production System (SPS), is a remotely controlled, buoyant, tethered, submersible vehicle depth-rated to 2,000 feet. All routine maintenance required on the SPS production, gathering, and distribution manifold is performed by the MMS using one of its two basic work tools or end effectors. Since SPS subsea equipment is maintained by replacing malfunctioning equipment packages, the primary task of the MMS is to transport a replacement package to the manifold, remove the malfunctioning package, insert the replacement, pressure test if appropriate, and return the replaced package to the surface. This is accomplished in one round trip. The MMS is electronically commanded and hydraulically powered. Redundant, self-contained power and controls improve the reliability. All work is observed with seven underwater closed-circuit television cameras, any four of which can be monitored simultaneously. To assist in lineup and acquisition, the end effectors are self-aligning. The work tool that maintains SPS valves generates up to 60,000 foot-pounds of back-out torque and 15,000 foot-pounds of make-up torque to provide the necessary preload on the 5,000 psi working pressure valve hub seals. The end effector that maintains SPS electro-hydraulic equipment can handle a 2,500 pound equipment package and uses hydraulic wrenches to open and close the two-bolt clamp that connects the package to the manifold. An extensive land and offshore testing program has verified adequacy of the design for further evaluation in the SPS pilot test. The MMS will soon begin actual work operations to maintain a three-well prototype SPS in 170 feet of water off the Louisiana coast.

31827 Template structure and installation: a subsystem of the submerged production system. Loth, W.D.; Burkhardt, J.A.; Covellone, T.A. pp 83-94 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The SPS template forms a rigid base for mounting SPS equipment subsystems, carries preassembled and pretested equipment during installation, serves as a drilling template, and provides a firm foundation for seafloor operations. Design of the template and procedures for installation evolved through a three-phase program of feasibility studies, detailed engineering, and field construction and installation. A template unit for the prototype 3-well SPS has been installed in 170 feet of water. This unit, a 90 by 120 foot structure fabricated from tubular goods and weighing 1,500 tons with pre-installed SPS production equipment, was installed using techniques developed for use in 2,000 foot water depths. The template unit was barged to location and launched in a conventional manner. After being brought alongside the drill vessel and rigged, the template was selectively flooded and keelhauled beneath the ship. The unit was lowered at a submerged weight of about 50 tons and oriented to a desired azimuth prior to being set on the bottom. Four foundation piles were installed and the template unit leveled on these piles to complete the installation. The template can be retrieved after well abandonment by deballasting flooded members, severing foundation piles and well conductors, and refloating.

31828 Dynamic and Fatigue analysis using directional spectra. Marshall, P.W. pp 143-157 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper briefly reviews historical development of spectral analysis, and derives a concise linear theory for spectral wave forces and resulting hot spot stresses, including directionality and spreading. After calibration, this is used in dynamic analysis and spectral fatigue damage calculations for a proposed thousand-foot platform in the Gulf of Mexico.

31829 Expendable acoustic command diver for emergency well head control. Patten, H.T. (Bunker-Ramo Corp., Canoga Park, CA). pp 437-443 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper describes a concept for providing fast and reliable acoustic backup control for Blowout Preventer stacks under catastrophic blowout conditions. The method described herein embodies both weapon pinger technology and antisubmarine warfare (ASW) deep-submergence sonobuoy technology. It is comprised of an acoustic pinger assembly which may be quickly launched from a drilling platform to free-fall at a high descent rate through the water column while cyclically transmitting a pre-programmed sequence of system arming and ram actuation acoustic commands to an acoustic receiver mounted on the Blowout Preventer stack.

31830 GBS: a new design of gravity platform with structure in steel. Picard, J.; Agnes, H. pp 83-87 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The GBS drilling, production and storage platform is of 100 percent steel construction and is an original and appropriate solution, where gravity platforms are being considered. It is not greatly affected by environmental forces. The optimized weight and the presence of skirts allow the platform to be adapted to very poor seabed conditions, as well as to take full advantage of good soil conditions. Construction of this platform fits in with the existing knowledge and expertise of steelworks and shipyards. The good stability of this platform during erection afloat and while being towed allows installation on the site location with all equipment on deck.

31831 Dynamic analysis of gravity type offshore platforms experience, development and practical application. Zijp, D.; van der Pot, B.; Vos, C.; Otto, M. pp 89-95 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The growing awareness of the importance of the dynamic behavior of gravity type deep water platforms is illustrated with a chronological description of the dynamic analyses of the Dun... 'A" platform. The following different stages can be recognized: (1) calculation of the dynamic amplification for a one degree of freedom system. (This simplification appeared to be too rough especially for the upper part of the structure.); (2) transient response analysis for a multidegree of freedom system. (The results of the fatigue calculation were unsatisfactory because the uncertainties of the input parameters were amplified by the dominant influence of the resonance waves.); and (3) spectral dynamic fatigue analysis. (In this approach the uncertainties are less and their influence is reduced.)

31832 Installation of the Shell/Esso Brent B Condeep Production Platform. Eide, O.T.; Larsen, L.G. pp 101-107 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

A brief description of the soil and site conditions for Shell/Esso Brent B, Condeep Production Platform, is given. The instrumentation of the platform for the installation phase is outlined, and some results obtained during penetration of the base of the structure into the seabed are presented.

31833 Concrete offshore structures, strains measured on full scale shells. Gausel, E.; Fluge, F.; Hafskjold, P.S.; Selmer, I.F. pp 119-122 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

A pilot study of the strain development in the first Condeep concrete platform, built by Norwegian Contractors, and now installed in the North Sea, has been completed at the Cement and Concrete Research Institute, The Norwegian Institute of Technology, University of Trondheim. The investigations are further intensified on the third Condeep platform, STATFJORD A, which is to be installed this Summer (1976). The main objective of the research program is to study the relationship between the measured strains and the external loads. This includes a study of the correlation between the elastic response of the structure and the modulus of elasticity of the concrete determined from standard tests. Conclusions concerning the modulus of elasticity and the magnitude of creep are drawn and compared with laboratory tests. The derived measurements should apply to hydrostatically loaded shells in general, not only to this particular type of concrete platforms.

31834 Certification of concrete gravity platforms in the North Sea. George, P.J.; Shaw, P.G.H. pp 132-141 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The Certification of a concrete platform requires an independent examination of the design and construction of an offshore structure. This paper confines itself to some aspects of the structural and foundation analysis of the Frigg CDPI platform carried out by Lloyd's Register of Shipping. Particular emphasis is placed on foundation studies, which played an important part in the acceptance of a new location at a late stage in the programme. These studies included: a detailed site investigation, laboratory testing of soil samples, finite element analysis and centrifugal model testing.

31835 Design analysis and construction of the Loango steel gravity platforms. Alloni, C.; D'Agostino, A.; Priarone, R. pp 149-156 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The paper deals with the four Agip/Elf steel gravity platforms, designed by Tecnomare and to be installed at Loango field (offshore Congo Brazzaville). Water depth at location is about 300 feet and the platforms are designed to accommodate 12 slanted conductors and 3 verticals. The platforms are assembled in Europe and towed for 5,000 miles to Congo in about three months. The origin of the particular structural geometry is explained together with the necessity to adopt a gravity platform instead of a piled one. Adopted design methods to analyze the structure during the construction, transportation and installation phases are described. Design steps are clarified for each of above phases, and main results are shown. The construction phases of the platform are summarized, and main procedures are discussed in relation to the main structural parts.

31836 Fracturing subterranean formation. Free, D.L. (to Dow Chemical Co.). US Patent 3,974,077. 10 Aug 1976. Filed date 19 Sep 1974. 8p.

As an aqueous fracturing fluid is pumped into a well bore penetrating a subterranean formation, a galactomannan gum, a buffer which promotes an initial acidic pH in the fluid, a borate ion releasing compound and a compound which functions to shift the pH of the fluid to the basic side after a certain short period of time are dispersed into the fluid. The resulting viscous fracturing fluid is employed to fracture a subterranean formation to, for example, stimulate the flow of fluids therefrom.

31837 Induction heating of underground hydrocarbon deposits. Fisher, S.T.; Fisher, C.B. US Patent 3,989,107. 2 Nov 1976. Filed date 10 Mar 1975. 8p.

The electric induction heating in situ of a selected portion of an underground deposit of hydrocarbons (such as petroleum, especially petroleum entrapped within a sand formation or the like, or lignite), for the purpose of facilitating extraction of hydrocarbons from the deposit is claimed. The heating is conveniently effected by passing alternating current through a conductor encompassing the selected portion. The conductive path is preferably a toroid, helix, or simulated toroid or helix, created by drilling and passing one or more conductors through the drill holes.

31838 Oil recovery by waterflooding employing graphite oxide for mobility control. Rodewald, P.G. (to Mobil Oil Corp.). US Patent 3,998,270. 21 Dec 1976. Filed date 1 Aug 1975. 8p.

A method is given for the recovery of oil from an oil-containing subterranean formation by waterflooding employing as an injection medium an aqueous dispersion of a hydrophilic carbon oxide. According to a preferred form of the invention, particulate graphite oxide characterized by a surface layer in which the molar carbon to oxygen ratio is from about 2 to about 3 is utilized as a viscosifier to decrease the mobility ratio between the injected water and oil, thereby improving the efficiency of the waterflood. The graphite oxide may be characterized by a surface substantially free of —COOH groups, thereby being insensitive to divalent metal ions present in the subterranean formation. According to another form of the invention, the graphite oxide is reactive with the divalent metal ions within the subterranean formation to form a plugging deposit and thereby to function as a sealant for highly permeable strata within the formation. 18 claims.

31839 Plugging a subterranean reservoir with a self-sealing filter cake. Lybarger, J.H. (to Shell Oil Co.). US Patent 3,998,269. 21 Dec 1976. Filed date 10 Oct 1975. 8p.

A subterranean reservoir is plugged by injecting a suspension containing solid particles of a resin capable of softening and resolidifying at the reservoir temperature. The particle sizes are correlated with the reservoir pore sizes so that particles are screened-out within and along the face of the reservoir formation. And, the particle compositions are correlated with the reservoir temperature so that the screened-out particles in and along the reservoir formation become fused into a substantially impermeable layer. 8 claims, 2 figures.

31840 Multiple fracturing of subterranean formations. Cooke, C.E. Jr.; Graham, J.W.; Muecke, T.W. (to Exxon Production Research Co.). US Patent 3,998,271. 21 Dec 1976. Filed date 31 Oct 1975. 8p.

A method of fracturing subterranean formations is presented wherein a formation is fractured and propped two or more times to increase the width of the propped fracture. 9 claims.

31841 Oil well gravel packing method and apparatus. Smith, D.M. US Patent 3,999,608. 28 Dec 1976. Filed date 22 Sep 1975. 8p.

A method is given for transporting gravel to a production zone with a circulating well fluid to uniformly pack the gravel in the annular space in the wall between the perforated liner and the formation whereby the fluid enters the perforated liner after depositing gravel at the top of the annular column of gravel and flows through the liner inner annulus into a tailpipe through which the well fluid is returned to the surface. The well fluid carrier for the gravel is prevented from entering the perforated or slotted liner except at the top of the gravel sheath by a semi-solid material prepositioned in the slotted liner-tailpipe annulus. The semi-solid material is progressively eroded by the well fluid entering the slotted liner-tailpipe annulus at the top of the gravel sheath. 11 claims, 4 drawing figures.

31842 Explosive well stimulation method. Field, H.S. (to Cabot Corp.). US Patent 3,999,609. 28 Dec 1976. Filed date 9 Jun 1975. 6p.

An improved method of well stimulation is disclosed involving the use of explosive mixtures performed downhole and employing the combustible components of the fossil fuel producing formation as the fuel component of the explosive mixture. 8 claims, 1 drawing figure.

31843 Oil recovery rate by throttling production wells during combustion drive. Bandyopadhyay, P.; Rhoades, V.W. (to Cities Service Co.). US Patent 3,999,606. 28 Dec 1976. Filed date 6 Oct 1975. 6p.

In a combustion process for recovering hydrocarbons from a subterranean formation vertically traversed by an injection well through which an oxygen-containing gas is injected and a plurality of production wells through which liquid hydrocarbons and gaseous products of combustion are produced, oil recovery is improved by throttling of the production wells to increase the steam pressure in the locus ahead of the combustion zone, and according to a preferred mode, the combustion front advance is controlled by selectively throttling and increasing the gas pressure of production wells in the vicinity of the greatest advance of the combustion front.

31844 Oil recovery by waterflooding employing a biopolymer-surfactant system. Savins, J.G. (to Mobil Oil Corp.). US Patent 4,008,766. 22 Feb 1977. Filed date 1 Mar 1976. 12p.

A process is described for the recovery of oil from subterranean oil reservoirs by waterflooding employing a multicomponent anionic-nonionic surfactant system in combination with a Xanthomonas polysaccharide thickening agent. The surfactant system and polysaccharide provide for an enhanced thickening action in the injected aqueous liquid at relatively low shear rates. The anionic surfactant employed is an amide-linked sulfonate and the nonionic component is a polyethylene oxide type surfactant. 11 claims, 3 figures.

PROCESSING

REFER ALSO TO CITATION(S) 31859, 32196

31845 Processing for new priorities. McWilliams, F.G.; Conser, R.E.; Vartivarian, D.K. (UOP Process Div., Des Plaines, IL). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 6, 244-249(Jun 1976).

The high cost of crude, and concomitant increased incentive to use petroleum resources efficiently, necessitates a review of processing schemes for fuels and petrochemicals. The synergistic effects on economics of combining petrochemical production and fuel production are investigated. The paper systematically develops the cost of producing petrochemicals and/or fuels with a variety of processing schemes which emphasize the production of fuels plus petrochemicals vs. fuels only. Included in the evaluation are classical refinery schemes which allow reference points to the projected process flows. Comparisons include use of hydrocracking vs. FCC as applied to petrochemicals production and the effect of crude throughput on overall refinery economics. Also included are case studies of hydrocracking vs. "J-Cracking" (FCC with hydrotreating of recycle light cycle oil) techniques when applied for maximum aromatics production and when included in the overall refinery flow scheme. If substantial reductions of gasoline lead contents are required, the "aliphatic route" to gasoline should be investigated. Economics for production of clear gasoline in the petrochemical-plus-fuels and fuel-only refineries are demonstrated.

31846 Continuous catalytic gasification of heavy hydrocarbon oils with recirculated fluidized catalyst. Kunii, D.; Kunugi, T. US Patent 3,989,481. 2 Nov 1976. Priority date 24 Apr 1973, Japan. 8p.

A continuous catalytic gasification of heavy hydrocarbon oils with recirculated fluidized catalyst bed is claimed. More particularly, it relates to such a process for the gasification in which solid fluidized catalyst having an average particle size of 0.05 to 2mm is recirculated through reaction and regeneration columns in a dense fluidized state, and wherein a heavy hydrocarbon feed stock is contacted with the fluidized catalyst and thermally decomposed and

gasified at a temperature of 650° to 1,000°C. 6 Claims, 3 Drawing Figures.

31847 Continuously adjusting the index of filtrability of a gas oil fraction. Louvel, B.; Vourron, B. (to Institute Francais du Petrole, des Carburants et Lubrifiants et Entreprise de Recherches et D'Activities Petroliers Elf). US Patent 3,997,432. 14 Dec 1976. Priority date 30 May 1974, France. 8p.

Adjustment and control of a product fraction stream and especially gas oil are effected by a control unit after processing information supplied by an analyzer that takes a direct measurement of the temperature of filtrability of the stream and by detectors which deliver signals representing the flow rate of the gas oil withdrawn, the rate of withdrawal of the next higher product stream, the flow rate of the crude petroleum being processed, the flow rate of the stripping vapor and of the next lower product stream, and the slope of the distillation curve of the crude petroleum in the gas oil zone. 3 claims, 2 drawing figures.

31848 Sulfur control over carbon formation in high temperature reforming operations. White, G.A.; Roszkowski, T.R.; Fleming, H.W. (to Ralph M. Parsons Co.). US Patent 3,999,961. 28 Dec 1976. Filed date 28 Oct 1975. 8p.

Hydrogen sulfide replaces a portion of the water required to suppress the formation of carbon in gas phase catalytic reforming and hydrocracking processes of hydrocarbons, particularly aromatics. Hydrogen is present to prevent carbon formation from the hydrocarbons. 14 claims, no drawings.

31849 Low-temperature steam reforming process for hydrocarbons. Uemoto, K.; Shichiji, S.; Amemiya, Y. (to Japan Gasoline Co., Ltd.). US Patent 4,000,988. 4 Jan 1977. Priority date 20 Jun 1973, Japan. 14p.

A process is claimed for manufacturing a methane-containing gas, which comprises introducing a feed hydrocarbon having at least 2 carbon atoms per molecule and steam preheated at a temperature in the range of 250°—600°C into a steam reforming reactor (or reactors) packed with a nickel-containing catalyst which has been prepared so that a solid solution consisting of a nickel oxide and magnesia is contained therein. Further a copper-chromium oxide or a copper-chromium-manganese oxide is contained therein and effects steam reforming reaction of said hydrocarbons while maintaining the temperature of the catalyst bed of said reactor(s) in the range of 300°-600°C.

31850 Method of removing contaminant from a hydrocarbonaceous fluid. Burger, E.D.; Curtin, D.J.; Edison, R.R. (to Atlantic Richfield Co.). US Patent 4,003,829. 18 Jan 1977. Filed date 2 Jun 1975. 12p.

Method is proposed for removing a contaminant, such as arsenic or selenium, from a synthetic hydrocarbonaceous fluid comprising providing a guard bed having a plurality of sections, a first section having from about 10 to about 75 percent of its volume occupied by a contaminant-removing material comprising, alone or on a carrier, either iron, cobalt, nickel, oxides or sulfides of these metals, or combinations thereof; the remainder being inert material. A second section of the guard bed has a major portion of its volume occupied by the contaminant-removing material. The feed oil, in the presence of hydrogen is contacted with the particles in the respective sections of the guard bed.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 32185, 32186

31851 Energy saving in connection with propylene/propane splitting. Schulze-Trautmann, H. (Deutsche BP AG, Hamburg). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 9, 403-407(Sep 1976). (In German).

Three different designs have been investigated for the fractionation of propylene and propane. Case 1: Conventional distillation with LP steam reboiler. Case 2: Two columns in parallel operation. The overhead vapors of the HP column are condensed in the reboiler of the LP column. Thus steam is basically required for the reboiler of the HP column only. Case 3: Distillation using the heat pump principle. The overhead vapors of the column are compressed in a gas-compressor and then condensed in the reboiler. The only energy required is that for the driver of the compressor. The economic comparison shows a significant advantage of the heat pump principle over the two other designs. Even the investment costs are slightly lower than in the conventional design.

HEALTH AND SAFETY

31852 Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975). 214p. (CONF-751257—). pounds 10.00.

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

Eight papers were abstracted and indexed separately for inclusion in the Energy Data Base. (LK)

31853 Techniques for assessment of electrostatic ignition hazards. Chubb, J.N.; Pollard, I.E.; Butterworth, G.J. (Culham Lab., Abingdon, Eng.). pp 21-25 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

Two ways have been described to assess the ignition hazard presented by electrostatic sparks: first, by using high frequency radio observations to monitor the occurrence of spark type discharges and to trigger flash photography of the situation responsible for the spark. With information on the size of bodies which could have discharged to particular parts of a structure the prospective discharge energies can be estimated by computer calculations with a knowledge of the electrostatic conditions present. The second route, which is under active investigation and development, is to obtain information on the parameters of individual sparks from the characteristics of the radio emission spectrum. These techniques enable information on electrostatic hazards to be obtained in practical situations where little may be known about the location or characteristics of the discharges occurring. The use of flash photography also provides a route to identify the changes in equipment design or operating procedures which would help to reduce the chance of occurrence of the more energetic sparks.

31854 Avoidance of electrostatic hazards during filling of road and rail tank waggons. Strawson, H.; Lyle, A.R. (Shell Research Ltd., Chester, Eng.). pp 26-31 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

Our earlier results show that a hazard could exist, not only during the initial stage in filling but also as the liquid level approaches projections from the roof. In addition, calculations show that the liquid surface potentials in the later stages in filling are unlikely to be significantly influenced by the initial filling rate. Therefore, limiting the initial filling rate to 1 m/s will not necessarily reduce the probability of a hazard in the later stages. Finally, it should be realized that, since not all the assumptions are supported by experimental evidence, changes may be necessary in any recommendations as further information is obtained.

31855 Electrical safety in oil tankers. Gray, D. pp 124-131 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

It should be apparent that the regulations for tankers contain restrictions and discrepancies; for example the acceptance of safe type motors on deck but not in enclosed dangerous spaces; the acceptance of flame proof lighting in pump rooms but of any safe type lighting in other dangerous areas. Restrictions and discrepancies always cause problems and frequently inhibit design. Already lighting fittings are available, not in flame proof construction, but which, in the opinion of many engineers, are superior to the flame proof type in performance and equal to flame proof type in safety aspects. All safe type equipment has been designed to operate with safety in dangerous atmospheres. The reluctance of the tanker engineer towards electrical equipment in dangerous areas is appreciated; it is based on long experience and is perhaps best summed up by the phrase, "If in doubt, keep it out". Nevertheless while it may have been possible in previous years to construct a tanker with no electrical equipment in dangerous spaces, it would be difficult if not impracticable to do so in the large ships of 1975. Once safe type equipment has been installed no matter in how small a quantity, inadequate maintenance will create hazard. Is it possible to design safe systems around an admission of inadequate maintenance. In the author's opinion perhaps the time has come to remove the restrictions and discrepancies and to follow shoreside practices vis a vis the use of safe type equipment.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 32705, 32706, 32707, 32708, 32709, 32710, 32711, 32712, 32713, 32737, 32743

31856 (PB—261500) **Petroleum market shares. Report on indices of market structure in the petroleum industry.** Unger, A.; McCauley, D.; Frederiksen, M. (Federal Energy Administration, Washington, D.C. (USA)). Apr 1976. 69p. (FEA/B—76/506). NTIS $4.50.

The study of competition in an industry focuses upon the analysis of its market structure, conduct, and performance. Principal descriptors of the market structure of the petroleum industry are the degree of vertical integration and horizontal concentration which it exhibits. This report presents a methodology for calculating an index of vertical integration and applies the methodology to the 1974 operations of 40 large U.S. refiners. The methodology is predicated upon a concept suggested in a 1954 study by McLean and Haigh. This study encompasses five stages: crude production, crude transportation, refining, product transportation, and product marketing.

31857 **Automated measurement on loading racks.** Goggin, C.D. Jr. (Gulf Science and Tech., Houston, TX). pp 343-349 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Criteria of the Elite information concept at a petroleum company center are examined. Information is presented on automated approaches and interactive centralized processing. A schematic of the Elite system is included along with schematics of Elite terminal equipment and software. (JRD)

31858 **Royalty verification of oil and gas accounting.** Armer, M.J. (Cutler Oil and Gas Corp., Chicago). pp 357-360 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Errors found in the development of oil and gas royalty verification systems are discussed. Information is included on verifying oil and gas income, testing royalty receipts, types of errors, and eliminating errors. (JRD)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 31767, 31768, 31865, 32772

31859 **Treatment of refinery wastewater and return to circulating water system.** Saifutdinov, K.Z.; Gerber, V.Ya.; Ioakimis, E.G.; Efimova, A.K. (Bashkir Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **10**: No. 11-12, 922-927(Nov-Dec 1974).

Results of an experimental investigation of the refinery wastewater recycling are presented along with technological recommendations. Wastewaters from the first sewer system in refineries ('industrial drain system'), before reuse in a circulating water system, should be given complete biochemical treatment and then post-treatment to remove the activated sludge. Design indices are proposed for the biochemical treatment and post-treatment of refinery 'industrial drain water', along with standards for the circulating water quality when these effluents are completely reused. The reuse of biochemically treated 'industrial drain water' instead of the mechanically treated effluent will permit a reduction in the rates of corrosion, scaling, and overgrowth in the circulating water, amounting to 34, 66, and 69% respectively. The quality indices of treated 'industrial drain water' reused in a circulating water system should conform to the standards for refinery circulating water. 6 refs.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 33203, 33207, 33211

31860 **Environmental considerations in the design of ballast water outfalls.** Johnston, C.S.; Halliwell, A.R. pp 235-245 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The development of the Occidental Group's North Sea Piper Field involves the operation of an oil loading terminal, with associated tanker deballasting problems, in the environmentally unspoiled Orkney Islands, Scotland. If minimal upset to a finely balanced marine ecosystem is to result, the nature of both effluent and receiving waters must be thoroughly understood. The multidisciplinary approach which led to system design, environmental appraisal and a comprehensive monitoring programme will be discussed.

31861 **Environmental aspects of produced waters from oil and gas extraction operations in offshore and coastal waters.** Koons, C.B.; McAuliffe, C.D.; Weiss, F.T. pp 247-257 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

This paper reviews the constituents of produced waters and their effects on both offshore and coastal marine environments. Interpretation of considerable laboratory and field data leads to the following conclusions: (1) Toxic components are in low concentrations in produced waters. (2) Natural forces such as dilution and evaporation, and chemical and biological reactions rapidly reduce the concentration of any toxic components in the produced waters to levels not harmful to the marine environment and biota. (3) Field data, in particular, show that continuous low-level discharge of produced waters has little to no detrimental effects on the marine environment or biota. This review paper was prepared to allay certain concerns recently expressed in environmental literature about possible detrimental effects on the marine environment of continued produced water discharges in offshore and coastal areas.

31862 **Nonvolatile hydrocarbons along tanker routes of the Pacific Ocean.** Brown, R.A.; Searl, T.D. pp 259-273 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Approximately 350 water samples were collected along 17,000 miles of tanker routes in the Pacific Ocean. Analysis of these samples for nonvolatile (C/sub 14+/) hydrocarbons gave a median concentration of 1.6 parts per billion (ppb) for the surface and 0.9 ppb in the subsurface at —10 m. Somewhat higher concentrations were observed for one voyage. The hydrocarbons were mixtures which seemed to be of both petroleum and biogenic origin. Data are presented for water along the routes: San Francisco/Cook Inlet, San Francisco/Vancouver/Panama Canal, and San Francisco/Singapore.

31863 **Fate and effects of oil on marine life: progress report on research sponsored by the American Petroleum Institute.** Lasday, A.H.; Mertens, E.W. pp 275-283 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Temporary exposure of a marine organism to oil does not result in permanent contamination. Since the oil is released by the organism, it cannot be concentrated by moving up the food chain to ultimately become a health hazard to man. As the composition of a spilled oil changes rapidly with time, toxicity is reduced due to evaporation of the most toxic compounds. Thus, the residues of oil after an offshore platform mishap become relatively inert before they reach the most biologically sensitive shoreline area.

31864 **Risk analysis and oil spill expectation for deepwater ports.** Moser, W.A.; Noel, M.P.; Heckard, J.M. pp 285-291 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Recent world-wide statistical data show that tanker spills generally amount to about 160 barrels of oil per million barrels shipped, of which between 40 to 70 barrels are spilled at the receiving port. This historical data base can be adapted to proposed deepwater ports in order to calculate the spill expectation at those ports. The methodology takes into account conditions existing at the proposed ports that afford benefits not occurring at the data base ports. By taking credit for these conditions, expected tanker spillage at two proposed deepwater ports (SEADOCK and LOOP) is demonstrated to range between 0.2 and 2 ppM of throughput, a much lower rate than that experienced at conventional ports.

31865 **Conditions for biodegradation of petroleum hydrocarbons at sea.** Tagger, S.; Deveze, L.; Le Petit, J. (Faculte des Sciences et Techniques, Marseille). *Mar. Pollut. Bull.;* 7: No. 9, 172-174(Sep 1976).

The hydrocarbon degradation potential of seawater appears higher in zones chronically polluted by these materials; they are characterized by an abundant bacterial development. The salinity of the effluent from a refinery and also its hydrocarbon content are factors affecting the speed of degradation.

31866 Colonial auks and eiders as potential indicators of oil pollution. Vermeer, K. (Canadian Wildlife Service, Delta, British Columbia). *Mar. Pollut. Bull.;* 7: No. 9, 165-167(Sep 1976).

Colonial auk (Alcid) populations can be used as indicators of the effects of oil pollution on the seabirds of Canada's coastal zones. Of approximately 11 million breeding colonial alcids in Canada and in adjacent West Greenland waters, 87 percent are murres. Common Eiders may serve as the best indicators of the effects of oil pollution in Canada's western Arctic where colonial alcids are scarce.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 32705, 32706, 32707, 32708, 32709, 32710, 32712, 32713, 32737, 32742

31867 Electrical equipment offshore. I. Statutory requirements. Moore, B.B. pp 183-188 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

Regulations pertaining to offshore installations operating in the British Continental Shelf are discussed. (LK)

31868 Electrical equipment offshore. II. Certification. McCrudden, F.D.S. pp 189-202 of In Electrical safety in hazardous environments. Stevenage, Eng.; Institution of Electrical Engineers (1975).

From 2. international conference on electrical safety in hazardous environments; London, United Kingdom of Great Britain and Northern Ireland (UK) (9 Dec 1975).

See CONF-751257—.

Electrical aspects of the Offshore Installations (Construction and Survey) Regulations 1974 and the Guidance Notes on the Design and Construction of Offshore Installations are considered. The regulations are brief and in essence require that standards of design and construction of offshore installations are adequate to ensure their safety in the conditions that may be experienced in waters surrounding the United Kingdom. They also require every installation to have in force a valid Certificate of Fitness. (LK)

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 31853, 31854, 31855, 31862, 31864, 31949, 31951, 31982, 32002, 32004, 33063, 33077

31869 Separator for separating radioactive krypton from argon. Miyazawa, T. (to Tokyo Shibaura Electric Co. Ltd.). Japanese Patent 1975-18,560/B/. 26 Aug 1972. 4p. (In Japanese).

Argon gas containing radioactive krypton exhausted from a nuclear reactor is caused to flow through a gas flow passage and exposed to a photon beam from a laser device or neutron beam to effect optical pumping of the gas. Argon gas is strongly excited by the laser beam and is thus accelerated in the direction of beam while the krypton gas is virtually unexcited and hence unaccelerated. A porous filter is disposed perpendicular to the direction of beam travel so as to pass only argon atoms having velocities higher than a specified value. The passed atoms of argon are collected and the krypton is drained from a port disposed at the end of the gas flow passage. Krypton is thus efficiently separated from the argon gas.

31870 Pilot-plant tests of long-distance transport of natural gas together with oil. Kirshenbaum, R.P.; Antip'ev, V.N.; Kagan, Ya.M.; Nazarov, N.M.; Soldatov, V.D. *Neft. Khoz.;* 5: 63-66(May 1975). (In Russian).

To determine the possibility of pumping oil together with gas over great distances, a pilot-plant experiment was carried out involving the use of a pipeline 52 km long and 720 mm in diameter. A study was made of the hydraulic regime of operation of this pipeline which involved simultaneous determination of the structure of the gas/liquid flow and measurement of the pressure pulsations. In addition, an estimate was made of the component composition of the gas along the pipeline.

31871 Automatic pressure control in pumped oil transfer mains. Zaitsev, L.A. *Neft. Khoz.;* No. 5, 67-69(May 1975). (In Russian).

Methods of flow throttling to prevent undesirable pressure fluctuations in pumped oil mains are reviewed. The characteristics and main requirements of the throttling elements used in pressure control are indicated, and the prospects for improvement of existing pressure control systems based on flow throttling are assessed.

31872 Measurement of ethane rich streams. Isaacs, S.F. (MAPCO Inc., Tulsa, OK). pp 342 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The content of ethane in a liquid flowing hydrocarbon stream greatly effects the weight to volume ratio, not only from a direct physical standpoint, but from a molecular standpoint of shrinkage. GPA exeriments have shown shrinkage as high as 6%. For this reason pipelines have tended toward mass measurement versus the pure volume method of measurement.

31873 Mass measurement of natural gas liquids. Templeton, W.J. (Cities Service Oil Co., Tulsa, OK). pp 350-352 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Mass measurement eliminates the need to compensate for the effects of compressibility and non-ideal mixing of stream mixtures containing ethane. Correction factors developed from physical properties are not required to convert the measurement to standard conditions, thus improving the measurement accuracy by 4 to 9%.

31874 Oil loss control in tanker operations. Zakrzewski, G.R. (Exxon International Co., New York). pp 371-373 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

An analysis of oil loss control in tanker operations is presented in sections on tanker oil loss exerience, cost of oil losses, cleaning losses, sludge buildup, evaporative losses, and other losses. (JRD)

31875 Liquid prover calibration. Green, C. Jr. (Daniel Industries, Inc., Houston, TX). pp 378-384 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A mechanical displacement liquid flow prover is described. The prover can be used in proving a meter under real operating conditions. The displacer design is discussed along with calibration technique, prover procedure, and data reduction. (JRD)

31876 Leak detection on petroleum pipelines. Young, H.A. (Mobil Oil Corp., Beaumont, TX). pp 393-398 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Leak detection systems for petroleum product pipelines are discussed. A description of the detection systems is included along with information on process calculations and process considerations. (JRD)

31877 High capacity liquid measurement systems. Keating, R.E. pp 408-412 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Pre-packaged, pre-tested high capacity flow control and measurement systems for oil and oil products are described. Several advantages of pre-packaged metering systems are discussed. (JRD)

31878 Liquid sampling. Graves, E.L. (Ernie Graves Co., Inc., Tulsa, OK). pp 413-415 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Advantages of various samplers are discussed. It is noted that samples should be taken at an area where turbulent flow exists. The importance of sample volume is discussed along with continuous sampling and sample handling. (JRD)

31879 Trouble shooting in metameter telemetering systems. Caraway, W.T.A. (Bristol Div. of ACCO, Waterbury, CT). pp 422-426 of

In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Troubleshooting in pulse duration telemetering equipment is discussed. Malfunctions of telemeter receiver recorders are discussed along with the use of volt-ohmeters in troubleshooting. (JRD)

31880 Wave forces induced on very large crude carriers. Muga, B.J.; Fong, H. pp 125-141 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper describes a theoretical method for predicting the forces induced by irregular waves on very large crude carriers, in which the hull section is modeled as a prismatic elliptic cylinder. Diffraction of the wave around the elliptic cylinder is taken into account and results are presented for surge and sway force and yaw moment for incident wave angles from 0° (headon) to 90° (broadside-on) at several increments and water depth to draft ratios. Thus, the effect of underkeel clearance is taken into account. In order to verify the method, an experimental study utilizing the captive model technique was carried out at the Netherlands Ship Model Test Basin (NSMB). In this study, forces (and moments) in the surge, sway and yaw directions were measured as the real tanker shape models were subjected to irregular waves incident from 0° to 90° at several values. The comparisons, which are presented in terms of the non-dimensional force (or moment) ratios, are considered to be excellent.

31881 Use of process control computers in the optimization of oil pipeline operation and safety. Loehner, E.; Janssen, E. (Rhein-Main-Rohrleitungsgesellschaft mbH, Cologne). *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 6, 237-243(Jun 1976). (In German).

After a brief description of the basic terms used in digital computing, the development of process control computer systems with regard to cost and number of systems installed worldwide is described. Hardware and basic software components are discussed. There are two basic applications of process control computers: (1) oil pipeline safety and supervision and (2) optimization. The known methods of supervision of pipeline—either already in practice or those for application in the near future—as well as the methods of optimization are described. Also discussed are the various configurations of process control computer systems. Finally, the paper deals with the future aspects of hardware and software.

31882 Marine facilities of the new Mobil Oil Refinery near Wilhelmshaven. Ehrenhauss, K.M. *Erdoel Kohle, Erdgas, Petrochem.;* **29**: No. 6, 249-253(Jun 1976). (In German).

In connection with its new refinery near Wilhelmshaven, the Mobil Oil AG in Deutschland ordered marine facilities near the deep water of the Jade Bay for receiving crude oil and for shipping refinery products. Logistics underlying the project and its particular design configuration are discussed. The various main parts of the marine terminal are then described, in the first line the island pier with mooring berth for tankers of up to 250,000 tons deadweight, and the submarine pipeline bundle which, consisting of 14 pipes and with its length of about 1000 m, is first of its kind in the world.

PROPERTIES

REFER ALSO TO CITATION(S) 33128

31883 Application of natural abundance carbon-13 nuclear magnetic resonance to crude oil and petroleum product analyses. Budde, W.L. (Environmental Protection Agency, Cincinnati). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 123-125(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The study applies Quantitative Carbon-13 Nuclear Magnetic Resonance (CMR) to petroleum analysis. Investigation was made of 4 crude petroleum and 2 petroleum products. Since polycyclic aromatic hydrocarbons are suspected of carcinogenic activity, they are under widespread study. The percentage of aromatic carbons in a sample is directly related to these hydrocarbons, and reliable, highly reproducible values of aromatic content can be obtained by CMR measurements on crude oils and distillate products. The analysis time is estimated at about 1 hr. with very little sample preparation time. The use of cracac as a relaxation agent is recommended along with the gating off of the spin decoupler during a 2 sec. delay between each data acquisition period and the start of the next pulse.

STORAGE

31884 Calibration of storage tanks. Owen, C.M. (Standard Oil Co., Cleveland). pp 399-407 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A procedure check list for use in calibration of petroleum storage tanks is described. Information is included on check lists, equipment, and measurement procedures. (JRD)

31885 Water-filled fire protection systems at Ekofisk. Martell, P.J. pp 417-428 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Tubular steel structures, including entire jackets and deck sections of template type platforms, can be protected against fire exposure by keeping the structural members full of water. The heat of the fire is absorbed by the water. Pressure from the fire water pumps, steam pressure from the evaporation of water, natural convection, or any combination thereof, will cause the water to circulate through a system of intercommunication openings. Steam and/or hot water vented from the system will be replaced with colder water from the fire pumping system. The temperature of the steel is thereby maintained at a safe level for structural integrity. This paper discusses this concept and how it was applied to specific structures in the Phillips Norway Group acreage of the Norwegian North Sea.

NATURAL GAS

REFER ALSO TO CITATION(S) 31788, 31791, 32745

31886 Survey of LNG technological needs in the USA—1974 to beyond 2000. Sarkes, L.A. (American Gas Association, Inc., Arlington, VA); Mann, D.B. pp 21p., Session VII, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

A comprehensive analysis of near and long term research needs has been conducted by the U.S. Gas Industry covering operational areas of production and exploration, synthetic supply, transmission, distribution, utilization, and LNG. Identifiable research needs are reported for the area of LNG encompassing time frames of: 1974—1978 (in detail, year by year), 1979—1985 (in 5 year period), 1986—2000 (as specific as possible), and beyond 2000 (as believed necessary). A year by year examination of LNG research priorities for the first five years are considered vital to overcome the potential suppression of growth in the LNG industry that could result from lack of available technology. Assessments of technical LNG needs beyond 1978 cannot, of course, be too well defined and must be examined annually for purposes of updating. The National Bureau of Standards cryogenics division has become the governmental focal point for LNG research. A survey of NBS LNG research and how these relate to the future technological growth of the LNG industry are discussed.

31887 Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). vp. (In English and French). (CONF-7406128—). $40.00.

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

Papers were presented concerning world trade in LNG, LNG transport, natural gas liquefaction, LNG handling, LNG storage, and economic and legal aspects. A separate abstract was prepared for each paper. (JRD)

31888 World trade in LNG from the Algerian point of view. Ait-Laoussine, N. (Sonatrach, Algiers). pp 11p., Session I, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The predominant position held by Algeria in LNG international trade is a result of the combination of natural factors such as the importance of the Algerian natural gas reserves and their geographical location in relation to consuming countries, with the desire

of Algeria to up-grade its natural resouces in a systematic and rational manner. The natural gas reserves of Algeria amount to 250 trillion cubic feet. This figure includes 100 trillion cubic feet of proved recoverable reserves, 30 trillion cubic feet of semi-proven reserves, 100 trillion cubic feet of probable reserves, and 20 trillion cubic feet of possible reserves. A great deal of effort is being made to delineate indicated reserves and to increase the total recoverable reserves. The Algerian policy with regard to the exploitation of natural gas is aimed, on the internal level, at developing the utilization of natural gas as an energy source for industrial and domestic consumption and as a feed-stock for chemical conversion, and, on the external level, at exporting large quantities of gas, namely under LNG form, to generate foreign exchange needed for national economic development. On the internal front, the efforts undertaken by Sonatrach have resulted in a considerable increase in national consumption--from 30 million cubic feet per day in 1962 to more than 200 million cubic feet per day in 1973. On the external front, some ten contracts have been concluded with various European and American clients which call for a total volume of 8 billion cubic feet per day of which 7 billion will be sold in LNG form. Of the 7 billion cubic feet per day of LNG, final transactions have been concluded for 3.25 billion cubic feet per day; the remainder is covered by contracts pending approval. The most recent contracts have been concluded under terms much more favorable to Sonatrach than those under which the first contracts were executed.

RESERVES

REFER ALSO TO CITATION(S) 31912, 31924, 32744

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 31795, 31803, 31804, 31805, 31806, 31807, 31808, 31822

31889 Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; University of Oklahoma (1976). 503p. (CONF-760498—).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

Papers and communications are presented dealing with charts, gas accounting, gas measurement, leakage, measurement of liquids, quality control, control equipment, regulatory matters, turbulence, and telemetering. Ninety-nine of the papers were processed individually. (JRD)

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 31796, 32187

31890 Production of a natural gas within specifications, from two LNG delivery sources. Torrent, C. (Gas Natural, Barcelona). pp 10p., Session IV, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Gas Natural, S.A., a natural gas distributing company with installations in Barcelona, Spain, started its operations with liquefied natural gas from Libya which has a high gross heating value (13,000 kcal/Nm^3). Methane and ethane obtained from the regasification and fractionation thereof are again mixed for emission to the network. Propane, butane and naphthas in the same LNG are marketed separately. A second deal for the purchase of LNG was later made with Algeria. This LNG, lighter than the Libyan, has a gross heating value (GHV) of 10,000 kcal/Nm^3 and, after vaporization, a Wobbe index of 13,000 kcal/Nm^3. Although both natural gases are interchangeable, their respective GHVs vary by 10 percent, which prevents their mixture at random. This might be coped with by identical production of both gases but strict planning in LNG deliveries to the terminal and absence of operational flexibility in the production lines would make the system impractical. The procedure adopted has been to liquate excess ethane from the Libyan gas by effect of the LNG cold and to store it in a separate tank for further addition to the Algerian gas, enriching it to the same GHV of the Libyan gas. Specifications are thusly met and no other regulating agents are required.

31891 Process and apparatus for treating natural gas. Solomon, S.M.; Shaievitz, S.; Marshall, L. (to Lummus Co.). US Patent 4,004,430. 25 Jan 1977. Filed date 30 Sep 1974. 6p.

A process and apparatus disclosed for recovering ethane and heavier hydrocarbons from natural gas by heating the natural gas stream prior to the expansion and introduction thereof into a demethanizer operating under cryogenic conditions. Ethane and the heavier hydrocarbons are recovered from the demethanizer as well as a residual gaseous methane stream which is compressed to a pipeline receiving pressure by the work of expansion without requiring a booster compressor. 10 claims, 1 drawing figure.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 31848, 31929

31892 Role of operational research and computing techniques in the LNG business. McCarthy, A.M.; Walker, H.W. (Shell International Gas Limited, London). pp 26p., Session II, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The aims and organization of the Operational Research and computer modeling activities carried out in support of the LNG projects in which Shell companies have an interest are reviewed. The scope and use of the principal models that Shell International Gas Limited has developed to help with LNG project studies both during the planning and the operational stage of schemes are outlined. Systems discussed include: the NAVIGATOR economics and finance model not only for deterministic case studies but also for Monte Carlo type analyses of risk; the COMPASS round voyage simulation model; and various models to assist in the planning of actual liquefaction plants' operations. A gas reservoir model and a pipeline model for gas gathering and/or gas distribution are also mentioned to illustrate the coverage of LNG projects as a whole.

31893 Optimum design of reliable LNG facilitites. Zellner, M.G.; Newton, C.L.; Phannenstiel, L.L. (Air Products and Chemicals, Inc., Allentown, PA). pp 16p., Session III, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The process design of a base load LNG liquefaction facility requires economic integration of commercially available equipment. To accomplish this, it is necessary to accumulate accurate physical property data and reliable equipment design criteria verified by plant performance evaluations. Over the past decade, APCI has developed computer programs for physical properties and equipment design. These programs are modular and have been combined into a powerful design tool named "Cycle Synthesis" which is a generalized heat and material balance system. The inherent features of this system allow it to be utilized not only for the initial design but also for rapid and accurate plant performance evaluations and determination of the sensitivity of the process to uncertainties in design information. Such evaluations are demonstrated to develop improved design criteria for LNG facilities. These criteria can be applied not only to base load LNG plants but also to shipping and receiving terminals and to peak shaving plants. Relative economic comparisons can be made for alternative process cycles, a task which would otherwise be formidable with less sophisticated computer systems.

31894 Skikda LNG project: appraisal of the plant construction, startup, and expansion phases. Tani, A.K.; Kassis, B.O.; Mac Intyre, D.B.; Bentamar, L. (Sonatrach, Skikda, Algerie). pp 19p., Session III, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Algeria's second major LNG grassroots project at Skikda is designed to process Hassi R'Mel gas for large scale LNG exports to France and USA. Commercial grades of ethane, propane and butane are also available for export and as feedstocks for plastics manufacture in the new industrial complex now under construction at Skikda. The first 3 lines, now being started up, are completely self-supported in terms of energy and utilities. Current total feed capacity of 5 billion m^3/year will be increased to 7 billion m^3 in 1975 on completion of a fourth line now under construction. In 1977, capacity will reach 11 billion m^3, by addition of a fifth and a sixth line. The first 3 lines incorporate the 2 pressure TEAL process and the second 3 lines will be based on the single pressure PRITCHARD design. The design philosophies are discussed, also the criteria used for sizing the units. The major equipment in the LNG and the utility plants is described, with the exception of the 78 Megawatt axial

turbo-compressors, which are discussed in a separate paper. Highlights are given of all phases of project development, with reference to the role of the technical advisors used by Sonatrach, for project engineering and inspection. Major construction problems experienced at the Skikda site are discussed, including liason between different contractors, bad weather delays, and corrosion of equipment. Details are given of operator and staff training, also integration with the constructors' operating teams. Commissioning experiences are described, with emphasis on the major incidents which caused frequent shut downs and delayed normal operation for 1 year.

31895 Construction and start-up of Skikda 1-2-3. Dolle, J. pp 8p., Session III, Paper 4a of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The construction and start-up of the Skikda LNG plant raised the usual problems of organization and coordination of the project, setting specific structures and utilization of an advanced technology. Those problems however, were greatly amplified by the size of the project. The role of engineering is highlighted with its large responsibility in developing such a plant. The importance of the human factor is emphasized.

31896 Performance of TEALARC liquefaction units in the Skikda plant. Bourguet, J.M.; Schlatter, R.G. pp 8p., Session III, Paper 4b of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The 1973 operating results of the Sonatrach plant in Skikda are presented and commented on in order to draw preliminary conclusions as for performance of the TEALARC liquefaction module. Process dynamic has been investigated during operations of start-up and shut-down, quick restart after a trip. The flexibility and stability of the installation have been demonstrated during this first year operating period.

31897 Determination of bottlenecks. Bendani, A. pp 15p., Session III, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The nominal production capacity of the gas liquefaction plant in ARZEW is 2,310,000 m^3 of LNG/year (330 days). The units have a peak capacity of 110 percent to cope with special interventions and shutdowns of limited duration. This fixes a minimum of 300 operational days in a year. There are 3 parallel units of liquefaction and one common natural gas treating unit. Bottlenecks can be split in 2 types: (a) the ones which prevent the nominal annual production capacity. (2) the ones which prevent the hourly peak capacity. Modifications of the initial design and the results obtained are presented.

31898 Contractor's role in managing a major LNG project requiring multinational cooperation. McHarg, R.E. (Procon Inc., Des Plaines, IL). pp 11p., Session III, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The world's largest gas liquefaction plant owned by Brunei LNG Limited is now in operation. This plant is situated on the north coast of Borneo in the State of Brunei. Procon Incorporated, as project manager, was responsible for: process engineering; technical consultation and coordination for detailed engineering; procurement in all nations outside Japan; worldwide shipping of materials to the site; and supervision of the plant's construction. Shell Internationale Petroleum Maatschappij N.V. (SIPM) was technical coordinator for the project; Japan Gasoline Company acted as prime contractor, performed the detailed engineering, and managed purchase, inspection and shipping of materials supplied from Japan. Numerous other parties participated as subcontractors and major suppliers. With such multinational involvement, the project presented many problems, reflecting the worldwide operations related to design, engineering, financing, procurement and shipping. Another challenge was the remote site, necessitating special considerations for construction personnel, materials handling, and communications. The size and complexity of the total project posed additional problems. Resolution of the problems, as evidenced by delivery of product, on schedule, from the largest cryogenic energy transport venture yet undertaken is discussed.

31899 Economic comparison of compressor drivers for LNG plants. Tanner, A.L.; Cooper, C.R.; Drucker, E.F.; Miles, E.J. (Fluor Engineers and Constructors, Inc., Los Angeles). pp 16p., Session III, Paper 7 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The results of an economic study of driver types for large LNG liquefaction plant compressors are presented. Simple cycle gas turbines, regenerative gas turbines, combined cycle turbines, and steam turbines are evaluated. The comparisons are based upon complete, installed costs of the driver installations and all directly related facilities and upon the annual operating costs. The effects of variable economic criteria, fuel value and climate conditions, are also presented. Performance characteristics and costs of turbines are not those of any single manufacturer but are generalized to represent the "state-of-the-art" today.

31900 Preliminary operating results of axial turbo-compressors at Skikda. Guguen, B.; Cherifi, M.S. (Sonatrach, Skikda, Algeria). pp 11p., Session III, Paper 8 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Preliminary operating experience at the Skikda LNG plant indicates that it is still too early to offer a final recommendation on the feasibility of using turbo-compressors in liquefaction cycles based on the mixed-refrigerant process. The turbo-compressor system at Skikda, rated at 73.5 MW, consists of a single turbine driving high-pressure and low-pressure compressors, with 77 percent of its power supplied to the high-pressure compressor and 23 percent to the low-pressure compressor. The turbine is controlled by changing its speed in response to the requirements of the low-pressure compressor. Prior to installation, the turbo-compressor unit was tested with air, natural gas, and refrigerant gas to check the effects of molecular weights and other parameters on the operating characteristics. Operating problems experienced included: rupture of the injection nozzle, causing breaking of the first-stage blading; deformation of the turbine casing; leaks at the horizontal joints; valve blockage in the intermediate recycling stage; automatic start-up control; blade damages; rupture of the valve system in the cold recycle stage; and vibrations and oil leaks. Most of the difficulties were solved by reducing the operating speed from 3240 to 3940 rpm to 3300 to 3450 rpm, modifying the equipment design, and changing materials of construction and operating conditions. However, the brief operating experience accumulated to date and the incomplete testing of these modifications prevent final recommendations concerning the feasibility of the application of turbo-compressors in the liquefaction of natural gas using a mixed-refrigerant process.

31901 LNG peakshaving plant operating experience. Sipple, P.A. (Air Products and Chemicals, Inc., Allentown, PA). pp 14p., Session IV, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Air Products has experienced a cumulative total of fifteen years operating experience with LNG peakshaving facilities. The three facilities owned and/or operated by Air Products represent 15 percent of the total LNG liquefaction capacity operational in the United States in 1974. A centralized, systematic approach to operations management is credited with the reliable and safe performance of these facilities. A computer co-ordinated control program is used to provide preventive maintenance task identification, compliance reporting and feedback data accumulation. The use of this program on a multi-plant system provides for effective communication with regard to procedures and other important factors which have a direct and immediate impact on plant performance. Safety inspections and test activities are included in the computerized control program. The task identification, compliance reporting, uniformity of application and data accumulation aspects of the centralized control program are all brought to bear on safety aspects of plant operation, thus increasing the effectiveness of loss prevention activities. The operating philosophy and techniques discussed are applied by Air Products not only in LNG peakshaving but in support of all of its operating facilities on a world-wide basis.

31902 Liquefaction and boil-off reliquefaction facilities at Canvey Island. Eke, P.W.; Graham, E.B.; Malyn, T.H. (British Gas Corp., London). pp 17p., Session IV, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

A plant capable of liquefying natural gas has been installed at Canvey together with a unit for the reliquefaction of compressed boil-off gas. The reasons for these developments are stated. Various possibilities were considered and the thinking which led to the final specifications is discussed. The liquefaction plant is described and some of the points of interest which arose during the commissioning are mentioned. One section includes design details and an account of the operation of the reliquefier, which enables compressed boil-off gas to be condensed by the LNG being sent out on base load. It is now possible to build up a stock of liquid methane of high purity. Mention is made of some of the uses of the material, the existence of which has enabled operations to be carried out more economically.

31903 Problems involved in the scale-up of LNG plants. Roger, D.G. pp 14p., Session VII, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

In spite of the experience gained by TEAL in installations such as peak shaving units or the CAMEL plant, a project like SKIKDA could not be constructed without raising many problems which had to be studied and overcome. These problems as well as those encountered at SKIKDA are set forth in this conference. The possibility of increasing the size of the plants in the future is studied taking into account this experience: the size limitation does not seem to be connected with cryogenic exchangers and the use of large size axial compressors may allow units with a capacity exceeding 3,000 million Nm^3/year of LNG to be contemplated.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 32029, 32033

31904 Boiling of liquefied hydrocarbons on water. Jeje, A.A.; Reid, R.C. (Massachusetts Inst. of Tech., Cambridge). pp 21p., Session VI, Paper 1 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

LNG (liquefied natural gas) is shipped at atmospheric pressure in insulated tankers and barges. Should an accidental spill occur on water, rapid vaporization results. To estimate downwind vapor concentrations, one must be able to determine the source rate of vapor evolution at the spill site. A spilled cryogenic liquid simultaneously spreads and boils. The cryogens studied were liquid nitrogen, methane, ethane, and several typical LNG compositions. The cryogenic liquid compositions, initial water temperature and quantity spilled per unit area were the primary variables studied. Boiling rates were measured by employing a load cell to monitor the residual mass of liquid cryogen. Temperatures were also measured continuously in both the vapor and the water. Initial boiling fluxes for liquid nitrogen ranged from about 8,000 to 11,000 Btu/hr-ft^2 and decreased slowly with time. For pure methane (99.98 percent), the initial fluxes were in a similar range, but they increased slightly with time. When even trace amounts (e.g., 0.1 - 0.2 percent) of heavier alkane hydrocarbons were present in methane, significant increases in the boiling flux were noted. With a lean LNG (98.2 percent CH_4, 1.62 percent C_2H_6, 0.11 percent C_3H_8 plus trace butanes), the boiling flux was almost two times that noted for pure methane, and the rate of increase of the flux was quite pronounced with time. Very high boiling fluxes were also noted for liquid ethane spills. No satisfactory theory has yet been formulated to explain all the results observed.

31905 Convection patterns in stratified LNG tanks: cells due to lateral heating. Griffis, K.A.; Smith, K.A. (Massachusetts Inst. of Tech., Cambridge). pp 13p., Session VI, Paper 4 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

Roll-over in LNG tanks has been ascribed to the rapid mixing of stratified layers which had resulted from the addition of LNG of a certain density to a tank already partially filled with LNG of a different density. Careful fill nozzle design can do much to achieve mixing during the filling process, but a residual concentration (and thus density) gradient always remains. Turner has described the formation of layers from such a gradient as a result of bottom heat flux; others have studied layer formation as a result of heat transfer from an isothermal vertical wall. Layer formation due to a uniform lateral heat flux, such as exists at an LNG tank wall, is investigated in this study. Experimentally, a water-sugar system has been used to model the methane-higher hydrocarbon system of interest, as justified by dimensional analysis. A concentration gradient is established in a 30 cm cube for which one side wall is of aluminum whereas all others are of Plexiglas; and the experiment is initiated by exposing the aluminum wall to radiant heat. This results in horizontal convection cells which are observed by dye tracer techniques and by shadowgraph. Preliminary results indicate that convective layers will be relatively thin for cases which are germane to LNG storage. For computational purposes, layers resulting from such lateral heating may even be assumed to be infinitely thin.

31906 Odorization. Laughlin, A.R. (Transcontinental Gas Pipe Line Corp., Houston, TX). pp 149-150 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Processes for adding odor to natural gas are described. Equipment for adding odorant is described along with odor detecting apparatus. (JRD)

31907 Odorization. Calaway, M.E. (Helmerich and Payne, Inc., Baytown, TX). pp 151-152 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The history and federal requirements for gas odorization are reviewed. Information is included on odorization equipment and testing procedures. An instrument, the Odotron, for measuring odorant concentrations in natural gas streams is described. (JRD)

31908 Odorization. Reynolds, L.E. (Reynolds Equipment Co., Garland, TX). pp 153-154 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A brief description of odorizers being used in natural gas is presented. Descriptions are given on absorption type odorizers, injection type odorizers, meter driven odorizers, diaphragm type odorizers, Bourdon tube type odorizers, and odorization by titration. (JRD)

31909 Instruments for leakage detection. Massicott, A.J. (Heath Consultants Inc., Houston, TX). pp 155-157 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Detectors available for finding natural gas leaks are described. Leak detection methods based on specific gravity, gas combustion, thermal conductivity, infrared radiation and hydrogen flame ionization are described. (JRD)

31910 Determination of leaks and unaccounted for gas. Massicott, A.J. (Heath Consultants Inc., Houston, TX). pp 416-418 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Surface and subsurface tests for gas leakage are discussed. Factors affecting or related to the tests including line pressure, odor, and location are examined. Evaluation of complex variations in gas leaks is discussed. (JRD)

31911 Keeping OSHA in perspective. Harp, J.D. (Florida Gas Co., Winter Park). pp 459-465 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The overall purpose of the Occupational Safety and Health Act is to ensure safe and healthful working conditions for employees. At this time, it is difficult to determine the actual effect that the Act has had on industrial accidents, due to the fact that some

changes occurred when the Act went into effect. Since the Act contains recordkeeping requirements, it is possible that these may have had some impact on the number of accidents reported, thus affecting the basis for comparison. National Safety Council statistics indicate an increasing frequency rate through 1973 with a slight decrease in 1974. It will be several more years before a valid comparison of accident statistics can be made. Compliance with the OSHA Regulations should not be considered as completely adequate to cover all areas of employee safety and health, but should be integrated into the overall company safety program.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 31858, 31935, 31948, 32743

31912 (CONF-7510152—1) **Assessment of world trade in liquefied natural gas.** Anderson, P. (Institute of Gas Technology, Chicago, Ill. (USA)). 1975. 20p. Institute of Gas Technology, Chicago, IL.

From CRYO/'75 conference; Los Angeles, California, United States of America (USA) (16 Oct 1975).

The potential for international trade in liquefied natural gas through the late 1980's is examined in terms of the natural gas reserves in the exporting and importing countries, gas supply forecasts for importing countries, LNG price, political and commercial constraints, and specifically proposed LNG trades. Source material for this assessment is drawn in large measure from reference presentations. It is concluded that the resource base is adequate to support the projected levels of international LNG commerce. Political and commercial constraints in the form of governmental policies and the risk of insufficient profit margins will provide the restraints to growth.

31913 **World trade in LNG: an American viewpoint.** Bennsky, G.M. (Dept. of State, Washington, DC). pp 18p., Session I, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

This paper provides an overview of existing and prospective LNG import projects for the United States, and it discusses the reasons why U.S. LNG trade may increase very little beyond the level presently planned. The location and quantities of world reserves for the projects under discussion are identified, and future U.S. import requirements are reviewed. Included also is a discussion of the duties and responsibilities of the U.S. Government agencies charged with regulating LNG imports into the United States.

31914 **World trade in LNG: progress and future prospects.** Peebles, M.W.H. (Shell International Gas Ltd., Shell Centre, London). pp 17p., Session I, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The current status of the world trade in LNG is examined by reviewing those projects which are now operational or can be considered to be firmly committed. Starting from these existing/firmly committed projects, a forecast is given as to how the world trade in LNG may now develop over the next 10 to 15 years in the light of recent trends and events in the world energy scene. These forecasts are compared with the previous predictions. Coupled with these forecasts are views on future ship requirements and on trends in LNG pricing. A brief review of the relative merits of alternative systems such as methanol, is given along with a short discussion of the commercial, technical, political, and other factors that could condition the future growth of LNG.

31915 **World trade in LNG from a financier's point of view.** Slater, P. (William Brandt's Sons and Co. Ltd., London). pp 8p., Session I, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The future of the world trade in LNG is considered and the ways in which the high cost vessels used to transport the liquefied gas can be financed are examined. The U.S.A., Western Europe, and Japan, already consumers of natural gas, are the main regions to which LNG will be transported over the forthcoming decade and, although emphasis is placed on vessel finance, the fact that this is but one link in the LNG chain must be borne in mind. Obviously the shipowners will take advantage of the available ship-yard credits, but they will need to look to banks and other financial institutions in order to raise the supplementary capital. Essentially their requirement will be for long term money and this paper explores the means of raising such funds and examines the possible sources of capital. Because LNG is essentially a new industry and is highly capital intensive, there are few historical financial techniques available which meet its present requirement. The demand is for long term funds in large amounts with preferably a fixed rate of interest. The sources of such funds are limited but some LNG ships have been financed and many others undoubtedly will be in the future.

31916 **Supply to Europe of Algerian natural gas in the framework of a multinational cooperation.** Bergmann, B. (Ruhrgas AG, Essen); Kirsch, J.; Meanti, L.; Tellier, J.; Verret, P. pp 16p., Session II, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

A Consortium formed by 7 Gas Companies of 5 Western Europe Countries (Austria, Begium, France, Germany, Switzerland) entered into an agreement with Algerian Sonatrach for the sale and purchase FOB Algerian coast of LNG 155 billions therms/year during 20 years. Buyers have formed the "Societe d'Achat de Gaz Algerien pour l'Europe" (SAGAPE) to carry out the purchase contract and for the sea-transport of LNG. That Company will charter four 125,000 m^3 methane-carriers, two of which to Algerian Shipping Company (CNAN). From the LNG terminals at Fos-sur-Mer in France and Monfalcone in Italy, natural gas will be transmitted through two transmission systems crossing five countries and connected together at the French-German border and to the previously constructed systems which will transmit to Western Europe high calorific value natural gas from U.S.S.R., the Netherlands and North Sea. For terminals and transmission systems buyers will form Companies in each of the crossed countries. Taking into account the participation of three other Gas Companies, it is a total of 10 Companies, which cooperate in order to realize in Western Europe the largest international transmission systems for natural gas.

31917 **Financing LNG carriers and ground facilities in the United States and European capital markets.** de Grandcourt, H. pp 18p., Session VIII, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Techniques developed in the United States and certain European countries to finance ocean-going oil tankers and industrial plants can be applied, with some variation, to the financing of LNG ground facilities. Discussions are presented on the legal structure of such financing, certain legal aspects of providing the credit and security required to support the investments to be made (including Government guaranties), problems relating to taxes, exchange controls, and regulation of importation and pricing of LNG. Particular attention is devoted to the following: lease (or charter) financing and other means of minimizing financing costs and obtaining credits with maturities substantially longer than have thus far been customary in export transactions; reliance upon the credit of entities whose ability to pay may depend upon an uninterrupted supply of LNG, and resulting modifications of conventional financing techniques; the peculiarities of different national capital markets and tax systems which affect the structure of each transaction.

31918 **Elements of gas contracts.** Babb, J.F. (Channel Industries Gas Co., Houston, TX). pp 466-472 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A brief review of gas contracts is presented emphasizing elements of wellhead purchase contracts. Information is included on types of gas contracts, definitions, gas quantities, commitment of gas reserves, measurement, price, taxes, and payments. (JRD)

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 32033

31919 **Measuring the environmental impact of domestic gas-fired heating systems.** Kalika, P.W.; Brookman, G.T. (Research Corp. of New England, Wethersfield, CT). pp 14p., Session V, Paper 1 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

This program utilized both measurement and diffusion modeling techniques to assess the impact of gas-fired home heating systems on two predominantly gas-fired residential areas. One residential area consisted of new homes less than 5 years old, while the other was made up of 14-year old homes and associated heating systems. The locations of these two areas precluded significant influence from other types of combustion sources external to the study area. Measurements were made during the heating season. In each area furnace emissions were measured at 50 homes. Nitrogen oxides, aldehydes, particulates and other pollutants were monitored. Concurrently the ambient air was monitored for NO/sub x/, CO and particulates, and meteorological variables were recorded. The diffusion model developed for this program utilizes as inputs emission factor data developed from the emissions inventory program and prevailing meteorological conditions, and then predicts air quality in terms of the pollutant selected. Measured air quality data are used to validate the model. The results will be used to assess in advance the air quality effects of various configurations of housing using gas-fired heating systems.

31920 Pollutant emissions from domestic gas-fired appliances. DeWerth, D.W. (American Gas Association Labs., Cleveland). pp 18p., Session V, Paper 3 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

Typical pollutant emission levels of CO, NO and NO_2 for various types of domestic gas-fired appliances have been measured. It was established that CH_4, C_2H_4, SO_2 and aldehydes are present in flue gases of well adjusted appliances in trace amounts that are insignificant from an air pollution standpoint. This type of data is needed by State and Federal authorities considering promulgation of Standards and by investigators of methods of minimizing pollutant emissions levels. Results are presented of a study of how range top burner design parameters affect top burner emission. Emission levels are correlated with top burner cap design, primary aeration and secondary aeration. Methods for minimizing range top burner NO/sub x/ emission are described; and a prototype 100 percent primary burner, which significantly lowered NO/sub x/ emission, is discussed. In addition to reporting forced-air-furnace pollutant emissions, two burner modifications are discussed which help to minimize NO/sub x/ emissions.

31921 Survey of the incidence of respiratory disease in households using gas and electric cookery. Mitchell, R.I. (Battelle Labs., Columbus, OH); Cote, R.W.; Lanese, R.R.; Keller, M.D. pp 13p., Session V, Paper 4 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

A study was undertaken to determine the incidence of respiratory disease in households in a midwestern suburban middle-class community, in a relatively unpolluted area. The sample included 441 families, divided into two groups; those utilizing gas cookery and those utilizing electric cookery, Family health and demographic data were obtained from the participants. The period of the study was one year. Reports of acute respiratory illness were obtained through bi-weekly telephone calls to each of the households. The respondents were asked to report respiratory illness in any member of the household, and to indicate the presence or absence of a set of signs and symptoms. Ambient air was analyzed, indoors and outdoors, in a sample of the households, and pulmonary function tests were conducted on a 42 percent sample of the participants, representing both types of household. The results of the study are presented with regard to reported incidence of respiratory illness in the two types of household. AID analysis and multiple regression were carried out to determine the best set of independent variables as predictors of respiratory disease incidence. This is the first in a series of studies. Subsequent studies will follow-up the reported respiratory illness to ascertain objective signs of illness and obtain bacterial cultures. Similar studies are also contemplated in areas in which the ambient air is more heavily polluted.

31922 LNG dike design. Parker, R.O. (Polytechnic Inst. of New York, Brooklyn). pp 6p., Session VI, Paper 3 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

Containment design for LNG spills is treated. Basic, but not essential to the treatment, is recognition that a finite time period is required for a large amount of liquid to be spilled. This and the fact that vapor generation rates decay with time lead to a rational design procedure. A general method is outlined. Design variations are suggested. A flow chart of an existing computer program for "instantaneous spill" is included in the paper.

31923 Environmental factors in siting LNG facilities. Warren, F.H.; Joyce, T.J.; Davis, R.J.; Firstenberg, H. (NUS Corp., Rockville, MD). pp 31p., Session VIII, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Growing international concern with preservation of our air, land and water resources, heightened by an increasing public awareness of the need for, and potential effects of, energy handling facilities has made it imperative that the LNG industry recognize, and take into account, environmental concerns at the earliest stages of the planning cycle. The reviews required by various federal and local agencies are outlined. The various factors which have a potential environmental impact, and therefore are also likely to be of concern to other national governments in developing environmental standards are listed. This paper sets forth typical issues presented by various environmental and ecological groups, indicating viewpoints which must be understood and appreciated. It illustrates the need for a comprehensive, detailed and technically precise evaluation which will be responsive to environmental factors and provide a planning base to minimize delays in gaining acceptance of LNG sites.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 31819, 31822, 31840, 31842

31924 Stimulation of tight Rocky Mountain natural gas reservoirs. Randolph, P.L. (El Paso Natural Gas Co., TX). pp 34p., Session IV, Paper 4 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

As of December 31, 1972, proved and potential reserves in the onshore and offshore areas of the 48 conterminous United States totaled 1,015 Tcf. Many gas industry research personnel appear to be overlooking the possibility of greatly increasing these reserves by research directed toward commercial production from the additional thousands of Tcf which exist in tight Rocky Mountain natural gas reservoirs. The Natural Gas Technology Task Force estimated that 600 Tcf of gas exists in place in the Green River, Piceance and Uinta Basins. This natural gas is currently considered noncommercial and was not included in the estimate of potential gas supply as of December 31, 1972. The Task Force report further reflects that research on nuclear stimulation and massive hydraulic fracturing may lead to ultimate recovery of 240 to 300 Tcf and that deliverability at the turn of the century may lie in the range of 2 to 7 Tcf per year. Actual production from this resource will be determined by future research on reservoir properties, especially on possible permeability increases and lateral extent of net pay intervals. Research should be directed toward well completion, especially on the development of sequentially detonable nuclear explosives; spacing of nuclear explosives to achieve vertical communication between chimneys; hydraulic fracturing fluid and proppants capable of creating and maintaining permeability in fractures with lengths of 1,000 feet or more; and developing means for vertical staging of hydraulic fracturing treatments without formation damage to previously fractured stages.

31925 Massive hydraulic fracturing, Rio Blanco Unit, Piceance Basin, Colorado. Appledorn, C.R.; Mann, R.L. (CER Geonuclear Corp., Las Vegas, NV). pp E3.1-E3.18 of In ERDA symposium on enhanced oil and gas recovery. Vol. II. Gas. Linville, B. (ed.). Tulsa, OK; Petroleum Publishing Co. (1976).

From ERDA symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, United States of America (USA) (9 Sep 1976). See CONF-760974—P2.

The Rocky Mountain massive hydraulic fracturing experiment was fielded in 1974 as a joint government-industry demonstration to test relative effectiveness of massive hydraulic fracturing in gas-bearing formations that were stimulated by the Rio Blanco nuclear fracturing experiment. The target formations in the project area, the Fort Union and Mesa Verde, are 4000 ft thick and estimated to have 74 billion cu. ft of gas in place per square mile. The potential reservoirs are lenticular shaly-silty sands in a thick section of shale and siltstone. The fracturing experiments are designed to interconnect these sand lenses with vertical fractures extending 80 to 200 ft in height and up to 2500 ft laterally from the wellbore. Extensive coring, logging, and testing of the well during and after

completion provided initial data for fracture design. The reservoir and physical characteristics of the rock are poor, but quite typical of the tight gas-bearing sands in the western Rocky Mountain basins. The shaly-silty sands have permeability in the low microdarcies, relatively high connate water saturations, and gradational contacts between shales, siltstones, and sands that provide little impedance to vertical propagation of fractures rather than the preferred horizontal propagation. Three fracturing experiments have been performed: two in the Mesa Verde and one in the Fort Union. Logging, production, and pressure testing are used prefrac to select sands for fracturing, and postfrac, to define fracture geometry and relative effectiveness of the technique. Both polyemulsion and gelled water-base frac fluids have been used to provide comparative data. The maximum longer-term postfrac to prefrac producing ratio obtained to date has been roughly 3:1, though higher ratios have prevailed initially. The experiment is being continued to determine fracturing techniques that will be effective in developing additional natural gas resources from the western Rocky Mountain tight gas sands.

31926 Potential role of geology in choosing fracture stimulation candidates: Mesaverde Formation, Northern Piceance Basin, Colorado. Chancellor, R.E. (Rio Blanco Natural Gas Co., Denver). pp E4.1-E4.11 of In ERDA symposium on enhanced oil and gas recovery. Vol. II. Gas. Linville, B. (ed.). Tulsa, OK; Petroleum Publishing Co. (1976).

From ERDA symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, United States of America (USA) (9 Sep 1976).

See CONF-760974—P2.

Subject area is underlain by some 4,000 feet of Upper Cretaceous shales and siltstones containing irregularly interbedded gas saturated sandstones throughout the interval. The sandstone beds vary in thickness from 5 ft to 200 ft. Well to well correlation on an individual basis is difficult due to depositional discontinuity. From 30 to 50 sandstone units are encountered in the sequence with cumulative thickness of more than 600 ft. Historically, completion work here has been hampered by inability to confidently designate those intervals with preferable reservoir characteristics. Present logging suites have helped in the selection process, but more definitive methods are required. The rocks are a complex interfingering of onshore and nearshore sediments. A regional study of their stratigraphy demonstrates that careful geologic work will assist in solving the selection problem. A massive stimulation in a well located in the vicinity of the Rio Blanco Nuclear and MHF Projects in Rio Blanco County is planned. Based on detailed stratigraphic analysis, the 150-ft Mesa Verde zone to be treated was deposited under conditions favoring good reservoir characteristics in a strongly hydrocarbon generating environment. The results of the stimulation, besides contributing to the growing body of engineering knowledge concerning tight gas sands, will indirectly furnish valuable information concerning the usefulness of geologic input in selecting frac candidates.

31927 Natural Buttes Utah massive hydraulic fracturing project. Spencer, W.E. (Gas Producing Enterprises, Inc., Houston, TX). pp E6.1-E6.9 of In ERDA symposium on enhanced oil and gas recovery. Vol. II. Gas. Linville, B. (ed.). Tulsa, OK; Petroleum Publishing Co. (1976).

From ERDA symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, United States of America (USA) (9 Sep 1976).

See CONF-760974—P2.

A massive hydraulic fracturing program is planned for eight wells in the Natural Buttes Field, a marginal gas field in the Uinta Basin of eastern Utah. The project is expected to cost $5.1 million, including five new wells. ERDA will contribute $2.2 million to the project. Different combinations of type and volume of fluid as well as size and amount of sand will be used in an effort to find the combination that results in the best gas flow characteristics.

31928 Status report on the MHF mapping and characterization program. Stoller, H.M.; Hay, R.G.; Schuster, C.L. (Sandia Labs., Albuquerque, NM). pp E8.1-E8.16 of In ERDA symposium on enhanced oil and gas recovery. Vol. II. Gas. Linville, B. (ed.). Tulsa, OK; Petroleum Publishing Co. (1976).

From ERDA symposium on enhanced oil and gas recovery; Tulsa, Oklahoma, United States of America (USA) (9 Sep 1976).

See CONF-760974—P2.

Geophysical diagnostic techniques are being developed to characterize massive hydraulic fractures. These techniques include the use of passive seismic signals created by the fracturing process and surface electrical potentials induced by injecting current into the fracture well casing subsequently modified by the fracturing fluid. Data obtained from several field experiments are presented to illustrate the status of these mapping techniques.

POLICY, LEGISLATION, AND REGULATION

31929 Policies for training operating personnel of future LNG plants in Algeria. Souidi, M. (Institut Algerien du Petrole, Dar-El-Beida, Algeria). pp 13p., Session VIII, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

As a pioneer in the fields of liquefaction and commercialization of natural gas, Algeria is being more and more solicited by various industrialized nations for sales and contracts of liquefied natural gas. Several of these contracts are either in effect or still in the process of negotiation. In order to satisfy the projected surge in demand, the rate of production of liquefied natural gas in Algeria will reach 80 billion m^3/y by 1980. Such high rates of production make it a necessity to train highly-qualified personnel capable of operating several plants, some already in operation and others still under construction. The Institut Algerien du Petrole has fully assumed its educational role in this respect. It has provided the trained engineers and technicians presently operating the Skikda liquefaction plant. The demands of new technology associated with this kind of industry, together with the urgent need for qualified personnel, presented a situation which called for the creation of a department of gas technology within the Institut Algerien du Petrole. This department will also incorporate the fields of research and technical services within its range of activities. As such, it is being considered as the first concrete step taken towards the establishment of an autonomous Algerian Gas Institute.

31930 Economic and legal aspects of LNG imported into the United States. Matthews, W.E. (Southern Natural Gas Co., Birmingham, AL). pp 16p., Session VIII, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Through its administration of the Natural Gas Act of 1938, the Federal Power Commission has jurisdiction over the importation of LNG, its sale for resale in the United States and the construction and operation of related facilities. The administrative process for obtaining Commission approval is initiated by filing certificate applications to import the LNG and to construct and operate the required facilities. These applications contain a detailed explanation of the project and a statement relating to its environmental impact. There are usually formal, administrative hearings on the application, and the Administrative Law Judge makes findings based on the evidence. The Judge's decision is reviewed by the Commissioners, who issue their own decision which, upon application, may be reviewed by appropriate courts. In the first major base load LNG project to be approved, the Commission imposed certain economic conditions on applicants. These conditions resulted, at least in part, from Commission concern over the relatively high cost of LNG and the complexities involved in a foreign based supply. If experience demonstrates that this concern was not well founded, similar conditions may not be imposed with respect to pending or future LNG projects. There are seven major LNG importation projects which have been approved by or are pending before the Commission. The paper will report on the current status of each of these seven projects.

31931 CM-A-12: a critical look at DOT inspection requirements. Williams, L.D. Jr. (Lone Star Gas Co., Dallas). pp 16-17 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A brief review is presented of DOT manual entitled Gas Pipeline Facilities Evaluation Manual. It is noted that the Federal Minimum Pipeline Safety Standards are now an integral part of the gas pipeline and distribution industry. Every company can benefit by careful planning of their code compliance program in order to prevent costly revisions later. Each program should be designed to generate the required procedures and records with as few personnel as possible and still have the flexibility to include future procedures that appear certain to come.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 31870, 31872, 31875, 31879, 31892, 31898, 31929, 31931, 32035, 32767

31932 Five year-ten year projection of worldwide shipyard capacity of LNG tankers. Robertson, I.W. (H. Clarkson and Co., Ltd., London). pp 19p., Session V, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

An appraisal of the likely magnitude of seaborne LNG trade in the period up to 1985 is presented. Five import areas likely to become significant are US East Coast, US West Coast, Japan, N. Europe and S. Europe. LNG import plans and projects are currently subject to rapid changes; range taken reflects political, economic, and social factors determining outcome of individual projects. Ship demand has been calculated for each individual project based on the following parameters: 125,000 m^3, 19 knots service speed, 4 days in port per round voyage, 345 days in service per annum, 0.20 percent per day average boil-off, and gas/liquid ratio 618:1. Estimates of 1975 trade volume and ship demand have been substantially reduced over the last 12 to 18 months by continuing delays in implementing major LNG projects. There is a "paper" surplus of 7 x 125,000 cbm equivalents as at end 1975. Since four ships have the capability to operate in LPG trades, the real end 1975 surplus of LNG carrier capacity is less significant than might appear. In mid-1972 approximately 30 shipyards had investigated the possibilities of constructing large LNG vessels. Owing to present shipbuilding boom few yards are now willing to make firm offers owing to high vessel cost, high risk factor to shipyard, and long deliveries. The mid-points between high and low ship demand estimates imply that deliveries in excess of current contracts will require an average of 10 to 11 ships per year through from 1976-1985 and further substantial delays to current projects would mean the greater part of total demand falling in the second half of the period.

31933 Arctic air/sea LNG project. Purvin, R.L. (Purvin and Lee Associates, New York); Withington, H.W.; Smith, C. pp 8p., Session VII, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The Air/Sea LNG concept proposes that a liquefaction plant be located at or near the center of a remote gas production area with an adjacent airfield capable of handling Boeing 747's on a routine all-weather basis. A fleet of Boeing 747's modified for LNG transportation would carry the LNG from this area to another all-weather airfield on the nearest point of land with access to ocean shipping, open consistently year-round with necessary airplane handling and LNG unloading facilities. The LNG would be transferred from the airplanes through a ship terminal located adjacent to the airfield into large LNG tankers specially designed, if necessary, for the mission which would deliver the LNG into terminals on the coast at or near the market area. It is estimated that a project delivering in the range of 600 million to one billion cubic foot per day would have a capital investment of approximately $2.00/per daily cubic foot of gas delivered for a system covering a total of 2,000 to 3,000 miles. Utilizing conventional financing mechanisms for the airplanes and ships and a utility rate of return for all other capital investments, it is estimated that the cost of service will range from $1.10 to $1.50/MCF for such missions. Utilizing the heavy ends of natural gas for airplane fuel, LNG for ship fuel and raw natural gas for liquefaction plant fuel, the shrinkage is about 25 percent and with this correction the cost of gas must be added to the cost of service for a total delivered cost into the market area. Based on current gas alternatives the delivered cost via this program would appear to be politically and economically feasible and attractive.

31934 Internal combustion engine fuel: studies and realizations in France. Bellus, F.; Humbert-Basset, R. (Gaz de France, Paris). pp 34p., Session VII, Paper 7 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Using natural gas as a fuel for internal combustion engines is not really an innovation, but the present fast growing of the LNG industry in the world makes it easier to be applied as a means to prevent air pollution by reducing the exhaust emissions from motor vehicles in urban areas, and also to diversify, within some limits, the energy supplies for transportation purposes. In France, Gaz de France, made agreements with vehicle manufacturers in order to study a gas-fueled engine offering the best performances with cleaner emissions than those of standard motors using gasoline or diesel-oil. In the same way, Gaz de France associated with specialists to set up the cryogenic equipment necessary for storing and vaporizing the LNG on the vehicles. A lot of experimentation has been performed on a testing platform as well as on a test track with the LNG equipment and a diesel motor converted to spark-ignition. The results which have been obtained allow, on a technical point of view, to consider as possible the conversion to LNG of centralized fleets of city cars particularly for the public transportation systems.

31935 Effect of intended trade route on the optimum size of LNG tankers. Lamb, T.; Castrinakis, E.; Arnas, T. (Value Marine, Alexandria, VA). pp 22p., Session VIII, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The size of LNG Tankers constructed and under construction in the world has increased by leaps and bounds from 1963 until the present. The largest under construction is 130,000 m^3, but designs for 200,000 m^3 vessels have been proposed. In the USA, the size ordered appears to be temporarily standardized around 125,000 to 130,000 m^3, but the vessels involved are for different routes with significant differences in round trip distances. Current intended routes for U.S. vessels are examined along with a number of feasible LNG trade routes. The study confirms the known fact, derived from other vessel types optimization studies, that the best combination of ship size, speed, and number in the fleet required to transport a given quantity of natural gas is very dependent on round trip distance.

31936 Alaska to Japan LNG project: Kenai revisited. Horn, J. (Phillips Petroleum Co., Bartlesville, OK); Tucker, P.W.; Emery, W.B. II. pp 10p., Session II, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The history of the Phillips-Marathon Alaska to Japan LNG Project has closely paralleled in time the history of the international LNG conferences. At LNG-1 in April 1968, a paper was presented covering the planning, design, and early construction of the project. In 1970, at LNG-2, a start-up and operational history was presented followed at LNG-3 in 1972 with a discussion of specific performance experiences. Coming full circle now, a discussion is presented on how this project would be developed if starting anew today, based on what was learned in nearly five years of operating experience.

31937 Early operating experience with the Brunei—Japan LNG project. Jenkins, J.E. (Shell International Gas Limited, London); Frieseman, F.; Prew, L.R. pp 22p., Session II, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The commissioning of the liquefaction plant at Lumut and operating experience to date are described along with the conventional and cryogenic trials of the LNG carriers, performance of the vessels in service, loading and discharge, scheduling arrangements and analysis of system capacity, and project management.

31938 Construction and operation of Tokyo gas, Sodegaura works. Kitada, S. (Tokyo Gas Co., Ltd.). pp 13p., Session II, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The Sodegaura Works of Tokyo Gas, the major Brunei LNG receiving terminal, previously reported at the 3rd LNG International Conference, has been completed and has commenced smooth operation. The Sodegaura Works will nave an eventual capacity to receive 8 to 10 million tons/year. Located next to the Sodegaura Thermal Power Station of the Tokyo Electric Power Co., Inc., it is a most up-to-date works for the processing of LNG both for town gas and for thermal power generation. New technology was used based on previous experiences in an Alaska LNG Project, the largest scale of which is the adoption of a full-size underground LNG tank. This tank is of the composite shell segment type as developed jointly by Tokyo Gas and Ishikawajima-Harima Heavy Industries. Other new technology incorporated includes a submerged vaporizer of high thermal efficiency and a turbo-type boil-off compressor, the latter being the first of its kind ever to be installed in a plant in Japan. On July 1, 1973, initial operation of the Sodegaura Works got underway with the arrival of the s/s Gadinia, a Brunei LNG carrier. The plant operated very smoothly and began producing town gas after about 30 days. The Sodegaura Works operation is performed by the Supervisory Computer Control-Direct Digital Controle (SCC-DDC) automatic operation system, which aims at achieving safety and consistency as well as labor saving. The system is functioning most satisfactorily.

31939 Columbia: consolidated LNG receiving terminal Cove Point, Maryland. Crawford, D.B.; Bergman, R.A. (Kellogg Co., Houston, TX). pp 15p., Session II, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

This terminal has a base load capability of approximately 1 x 10^9 SCFD of natural gas and the basic information regarding site selection and on-shore facilities will be discussed; the criteria for selection of tankage, vaporizers, pumps and compression equipment will be presented. The off-shore facilities including piers and docks and the undersea piping tunnel connecting the on-shore and off-shore facilities is reviewed. The terminal arrangement and the design basis for the storage system, ship unloading rate, vapor displacement, dynamic flow analysis, and vaporization and send-out system will be presented. The specific mechanical design problems associated with this terminal will also be discussed.

31940 Computer program for optimization of LNG transportation. Oshima, M.; Narita, H.; Kunitake, Y. (Mitsui Shipbuilding and Engineering Co., Ltd., Tokyo). pp 22p., Session II, Paper 7 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

A computer program was developed called TRANSAP-LNG for system design and economic evaluation of LNG transportation systems. The system model in this TRANSAP-LNG includes all the stages related to LNG transportation, such as gas wells, gas pipelines, liquefaction stations, terminal facilities, LNG tankers and gasification stations, and since these subsystems, either single or multiple, are linked together as a total system, optimization of the total system of multiple projects can be made as well as optimization at lower system levels, including optimization of LNG tanker in view of total transportation project. TRANSAP-LNG consists of four main program packages designed for the following purposes: (1) optimization of a total system (by Linear Programming method), (2) evaluation of the total system of a given system model, (3) analysis of sea transportation system including terminal facilities, (4) optimization of LNG tanker.

31941 Custody transfer instrumentation systems for LNG marine transportation projects. Moore, C.F. (El Paso Natural Gas Co., Houston, TX); Blanchard, R.L. pp 18p., Session IV, Paper 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

LNG is a cold liquid form of energy which is becoming a significant factor in the world energy picture. An international LNG project involves liquefication of natural gas in an "energy surplus" area and transporting it in liquid form to "energy deficient" areas. It is now almost standard practice to buy and sell LNG on heat content basis using shipboard gaging systems for the determination of the total heat in the LNG loaded or discharged. The instrumentation which is used to determine the amount of energy bought or sold is referred to as the "Custody Transfer Instrumentation System." This system is used to determine the various parameters such as density, temperature, and liquid levels necessary to determine the total heat content of the LNG. The measurement system must be of an accuracy which will satisfy the seller, buyer, customs, and other government authorities. As the value of LNG increases, there is a continuous demand for greater accuracy in LNG measurements. This means that greater precision is required in LNG measurements than is normally used for crude oil and other petroleum products. Details are given concerning the type of Custody Transfer Instrumentation System which will be installed in the ships of the El Paso LNG project between Algeria and the United States. The system concepts and type of hardware involved, operational experience, and illustrations of the equipment that will be used are included.

31942 Method used at the receiving terminal of FOS-sur-MER to determine the therms delivered by SONATRACH to Gaz de France. Farrugia, M.; Chevalier, M. pp 17p., Session IV, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The different measures are described that are taken on board the LNG carrier and ashore in order to determine the number of therms delivered. LNG carrier on-board procedures include reading of the temperatures in the LNG cargo tanks, determination of the total volume of LNG unloaded, the figure being given by the volume of each cargo tank before and after the unloading, determination of the density of the LNG in kg/m^3, and calculation of the weight of the unloaded LNG from the preceeding datas. Unloading dock procedures include a continuous sampling of the LNG during the unloading and the regasification of the sample through an integral vaporizer feeding the chromatograph, and determination of the composition of this LNG through an industrial automatic chromatograph in gaseous phase and through an electronic calculating set with a printer giving the gross calorific value of the natural gas expressed in therms per kilogram.

31943 Thermal and thermodynamical aspects regarding the operation of LNG trades. Morel, J.P.; Pascual, L. (Technigaz, Paris). pp 29p., Session V, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Afer recalling the nature of the thermodynamic phenomena associated with storage and transportation of LNG, the approach to these phenomena applied and developed by TECHNIGAZ is presented. This approach is based on the data gathered from operation of methane carriers such as the "DESCARTES" and the "GADINIA," and land based installations such as the ethylene tanks of NAPHTACHIMIE, TOTAL-CHIMIE and TERQUIMSA. Concerning the boil-off, the three dimensional temperature gradient existing in the TECHNIGAZ insulation for LNG carriers and the vertical temperature distributions in land based storage tanks as calculated by the CATEPA program are examined. The corresponding experimental data are also examined and compared with the calculation results. A flash simulation model, taking into account the internal heat transfer, has been established for very large tanks. This model makes it possible to predict the instantaneous flash rates during and after each loading operation. Questions related to gas return and reliquefaction units are approached taking into account the response of the product after stops and starts of gas suction. A model (PREVAR program) is used for the study of problems concerning the tank pressure variations under stable and transient conditions. Numerous experimental results are included. The generalization of the proposed model to a liquid phase with a variable composition is used to explain the roll-over phenomenon. The thermokinetics of methane carrier tanks are examined from the following points of view: cooling and heating of the tanks, definition of LNG spraying parameters, and estimation of the additional boil-off after loading. The experimental results in this field are based upon observations effected on methane carriers in service.

31944 Safety considerations in the design and operation of LNG terminals. Anderson, P.J.; Bodle, W.W. (Inst. of Gas Tech., Chicago). pp 16p., Session V, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Safety considerations are of prime importance in the design and operation of LNG base-load terminals. This paper outlines safety considerations applicable to the major components of a terminal facility, which include the docking facility, LNG tanker liquid transfer and vapor handling, storage, and sendout vaporization. The docking facility must be designed to safely withstand ship impacts and the effects of tides, waves, and winds. Liquid transfer and vapor handling systems must provide for the safe operation of ship connections, unloading arms, liquid and vapor transfer lines, and liquid-recirculation loops. The safety of storage systems is affected by mechanical design features as well as by operational characteristics such as liquid roll-over, liquid pumping rates, and changes in barometric pressure. Vaporization equipment must provide for control of gas sendout temperature. General safety considerations for the entire facility must include provisions for combustible-gas detection and for the location of fire-sensing devices at strategic locations throughout the plant area. Fire-control systems must also be provided. The proper selection and training of personnel are vital for the safe operation of LNG terminals.

31945 Shipboard jettison tests of LNG onto the sea. Knebone, A. (Shell Research Limited, Chester, Eng.). pp 25p., Session V, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The seven Shell 75,000 m^3 LNG carriers scheduled for the Brunei-Japan scheme are fitted with a stern LNG jettison line. This system is intended to allow safe discharge of LNG to the sea under the following conditions. The ship underway has suffered failure or damage to the cargo containment system to the extent that it is essential to empty the damaged tank to prevent further serious ship failure. The ship is stationary, i.e., aground, and it is necessary to lighten the ship and refloat to avoid further hull damage and possible risk of major release of cargo. While limited stern discharges of LNG have been carried out, to our knowledge, it has not been attempted with large quantities and high flowrates, or with the ship stationary. The first part of the paper describes the procedures and

results of a series of jettison tests carried out on board the 75,000 m^3 ship Gadila with ship moving and stationary and discusses the operational safety aspects of such discharges. The second part is concerned with the environmental hazards associated with the release of large quantities of LNG to the sea in terms of the extent of vapor cloud formed, its characteristics and rate of dispersal.

31946 Shipboard reliquefaction of boil-off: technical and economic considerations. Lorenzen, J.A. (J.J. Henry Co., Inc., New York). pp 14p., Session V, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The operational, technical, and economic requirements for shipboard LNG reliquefaction plants are reviewed, including the effects of vessel size and operating environment. Some data are presented to guide the investigation of the feasibility of applying such plants. Various commercial systems are outlined to provide background for discussion.

31947 LNG inland transportation with railway tank cars and river-going tankers. Backhaus, H.W. (Natural Gas Service Deutschland GmbH, Ramagen-Rolandseck, Germany); Janssen, R. pp 16p., Session VI, Paper 2 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The inland transportation of LNG may be effected by river-going tankers and unit trains. In Europe the transportation of LNG by tankers is for the most part confined to the Rhine. Considerable restrictions, therefore, have to be accepted both as regards the location of the coastal receiving terminal and the inland storage facilities. On the other hand, transportation by unit trains is much more flexible. The coastal receiving terminal is independent of river estuaries and can be chosen strictly in terms of its best possible market situation. Moreover, the dense network of European railways enables LNG to be transported to all evisaged consumer centers. Indeed, an intra-European link-up would be feasible by which LNG supply to an inland receiver could be maintained, even if his own coastal terminal drops out. Another advantage is the possibility of combining unit trains which could be rapidly operated in accordance with time tables. The train can be uncoupled upon arrival and single cars further distributed, which means a continuous bulk and small-scale LNG transportation without repeated unloading.

31948 Moving natural gas from the arctic to markets. Kniel, L. (Lummus Co., Bloomfield, NJ). pp 19p., Session VII, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

An investigation is made of the merits of possible transport modes to move natural gas from the Canadian arctic islands to mainland Canada and the USA. Fuel requirements and delivered payload data are presented. An air-sea combination transport route appears as the most viable solution. Further arctic ice research is necessary to define sharply the requirements and configuration of tankers operating in arctic waters. The concept of a shipboard liquefaction plant is outlined and described in some detail. An expansion type liquefaction cycle appears to be the most adaptable for shipboard installation.

31949 Simultaneous pipelining of solidified crude oil and LNG. Jensen, E.J. (Research Council of Alberta, Edmonton). pp 15p., Session VII, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The concept of moving solidified crude oil in LNG in a single pipeline is considered. The idea was developed at the Research Council of Alberta and is proposed as a means of transporting hydrocarbons from the Canadian Arctic with a minimum of damage to the environment. The Canadian petroleum resource situation is presented, and it is pointed out that the Mackenzie Delta crude oil potential is too small to warrant the construction of a large diameter pipeline. The crude oil-LNG pipeline proposal is defined and solids pipeline technology relevant to the implementation of it is reviewed. A hypothetical crude oil-LNG pipeline from the Mackenzie Delta to the Athabasca Oil Sands deposits is discussed. It is concluded that the proposal shows sufficient promise, both technologically and economically, to justify further work.

31950 Overland transportation of imported LNG in Japan with special reference to the quantitative measurement of LNG. Hirakawa, S. (Univ. of Tokyo); Sugiyama, S. pp 12p., Session VIII, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The importation of LNG in Japan is growing rapidly year by year and the measurement of LNG has received increasing importance. General aspects of LNG, overland transportation status, and natural gas distribution activities of importing LNG into Japan are examined. The important points and general precautions applied to the measuring techniques are discussed. Measuring techniques on Japanese LNG pipeline and LNG storage tanks in the receiving terminals, as well as LNG tanklorry, LNG rail tank car, and LNG container in overland transportation are summarized. A discussion on the accuracy and reliability requirement for the quantitative measurement of LNG is given. Also, the trend for measuring LNG in turbine flow meters for cryogenic use and automatic loading devices is included.

31951 Electronic chart scanning and related equipment. Burr, A.; Tidwell, L.G.; Williams, M.L. pp 4-12 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

An electroscanner for use in flowchart processing is described. The chart, illuminated by a mercury vapor lamp, is rotated on a motor driven chart table. Above the chart table is a large revolving disk with lenses mounted on its circumference. The size and location of the disk is such that the lenses pass over the chart in an arc similar to that followed by the recording pens of the meter. During one 360° revolution of the chart, 800 observations or scans are made. As each lense crosses the chart, light is gathered and passed via a prism and a mirror to a photomultiplier tube which produces an electrical signal. When the lense passes over a recorded trace, little or no light is reflected to the photomultiplier tube and the electrical signal changes. The scan disk also has the necessary components to generate a signal when the lense is at the zero and full scale points of the chart. Since the scan disk turns at a constant speed, the amount of time required for the lense to travel from zero to each trace is proportional to the trace value. Using this information the computer assigns a value to each trace and computes the value for each scan. Results are displayed on a nixie tube readout and the accumulated value is printed onto a tape.

31952 Large capacity displacement meters. Simpkins, J.A. (Rockwell International, Pittsburgh). pp 18-21 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Diaphragm type meters having a capacity of 500 to 11,000 cfh natural gas are described. Evolution of modern large capacity meters is discussed along with meter construction, meter sizing, and large capacity meter installation practices. (JRD)

31953 Domestic meters. Smith, T.J. (Singer Co., Philadelphia). pp 22-31 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The history and operation of domestic gas meters are reviewed. Information is included on meter improvements, performance, calibration, factors affecting accuracy and remote reading equipment. (JRD)

31954 Domestic meters. Esola, J.L. (Rockwell International, DuBois, PA). pp 27-31 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Positive displacement gas meters are examined. Discussions are included on meter requirements, meter operation, meter construction, meter repair, and temperature compensation in gas meters. (JRD)

31955 Rotating vane type meters. Lints, W.W. (Singer Co., Erie, PA). pp 32-34 of In Proceedings of the fifty-first International

School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The four-vane gas meter is described. Information is included on operation, installation, size selection, field maintenance, accuracy testing, and modifications. (JRD)

31956 Gas measurement by rotary meters. Whittemore, J.P. (Dresser Measurement Div., Houston, TX). pp 35-42 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Operating principles of rotary gas meters are described. Information is included on the Roots meter, Rockwell Roto-Seal meter, meter sizing, types of rotary meters, installation, and maintenance. (JRD)

31957 Methods of field testing large displacement meters. Grimes, R.L.; Groves, W.M.; Epps, V.E. pp 43-44 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Field testing of large displacement meters by the transfer proving method is described. Information is included on transfer testing and techniques of field testing. (JRD)

31958 Low pressure flow prover. Groves, W.M. (United Gas Pipe Line Co., Victoria, TX). pp 45 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Proof testing large capacity displacement gas meters in the field using the low pressure flow prover is described. (JRD)

31959 Field testing with the critical flow prover. Epps, V.E. (Southern Natural Gas Co., Atlanta). pp 46-47 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Procedure and equipment for testing displacement meters using the critical flow prover are described. Test equipment items are listed and discussed along with methods of computing the proof of the meter. (JRD)

31960 Large capacity displacement gas meters. Thomas, W. (Singer Co., Philadelphia). pp 48-50 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Large capacity gas meters, classified as those capable of measuring more than 500 ft^3/h, are discussed. Information is included on construction, operation, capacity, and testing. (JRD)

31961 Correcting instruments for displacement and turbine gas meters. Fulton, D.R. (Mercury Instruments, Inc., Cincinnati). pp 51-53 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A description is presented of the Mercor III direct reading volume integrator, meter mounted, manufactured by Mercury Instruments, Inc. It is adaptable to large volume gas meters including diaphragm, rotary, and turbine types. The Mercor III automatically provides a corrected volume readout on any gas meter having a rotating shaft output. It converts displaced volume to a standard volume, referred to a pressure base and/or temperature base. Supercompressibility correction can also be built into the integrator.

31962 Diaphragm meter capacity ratings at elevated pressures. Holmes, H. (Sprague Meter Div. of Textron, Bridgeport, CT). pp 54-57 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Two methods of calculating diaphragm gas meter capacities at elevated pressures are outlined. Equations are derived for use in the calculations and resulting data are tabulated. (JRD)

31963 Large volume gas measurement by turbine and rotary meters. Humbert, S.F. (Mergas Meters, Inc., Cincinnati). pp 58-64 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The design and operation of turbine and rotary gas meters are reviewed. Advantageous features of the meters are outlined and installation procedures are described. (JRD)

31964 Fundamental gas laws. Townsend, F.M. (Univ. of Oklahoma, Norman). pp 65-77 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Use of the gas laws in gas measurement is examined. Effects of temperature changes in gases and vapors are discussed along with properties of gases. Terms including absolute temperature and pressure are defined and pressure units-conversion is explained along with the pound-mole system. Gas-vapor concepts as applied to gaseous mixtures are examined. (JRD)

31965 Overall measurement accuracy. Holmes, H. (Sprague Meter Div. of Textron, Bridgeport, CT). pp 83-92 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Gas measuring methods are analyzed. The methods are: 1. Commercial and industrial measurements at elevated pressures using (a) fixed factor billing method, (b) average pressure factor billing method (c) pressure compensating indexes, and (d) correction type instrumentation. 2. Low pressure system measurement. 3. Low pressure measurement individually regulated from elevated pressure service lines. (JRD)

31966 Selection, testing, maintenance, and operation of electronic flow computers. Strickland, J.L. Jr. (United Gas Pipe Line Co., Houston, TX). pp 105-107 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Computerized gas flow rate equipment is described. Gas equations for use in the flow calculations are derived and the incorporation of transducers in the measuring system is described. Applications of analog and digital computers in the measuring system are discussed. (JRD)

31967 High pressure measuring and regulating station design. Rodman, F. (Cities Service Gas Co., Oklahoma City). pp 108-111 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Factors involved in designing high pressure regulating and measuring stations are reviewed. Information and discussions are included on station requirements, meter selection, pressure regulation, overpressure protection, and auxiliary equipment. (JRD)

31968 New ideas in gas measurement and pressure regulation. Wager, J.A. pp 112-119 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Recent developments in gas measuring and pressure regulation equipment are reviewed. Data and information are included on elbow type differential-producer flowmeters, automation of bell type prover measurement, acrylic protectors for meter index and axle boxes, leak tester improvements, mini prover development, temperature compensator automation, meter reading automation, data telemetering systems, and domestic transfer provers. (JRD)

31969 Test instruments for pressure, water vapor, and supercompressibility. Chandler, A.W. pp 120-124 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Volume measurement of natural gas at high pressure is principally accomplished by means of orifice type flow meters. Converting orifice meter readings to low pressure volumes requires exact knowledge of pressure and supercompressibility. Also, it is desirable to measure and limit the water content of natural gases. Water, in free or vapor form, will cause operational difficulties at meter stations and regulators. Free water is easily disposed of, but it is necessary to measure water vapor content in order to maintain a value low enough to prevent difficulty. Instruments used in these areas are described including pressure indicators, dead weight gages and testers, dew point testers and recorders, and supercompressibility apparatuses. (JRD)

31970 Flow measurement by insertion turbine meters. Pfautsch, D.A. (Electronic Flo-Meters, Inc., Dallas). pp 131-137 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The insertion turbine meter is used to measure the flow of liquid or gas in large lines. A general description of this meter is presented along with basic specifications, applications, installation methods, and maintenance. (JRD)

31971 Use of manometers in the gas industry. Gestrich, N. (Div. of the Scott and Fetzer Co., Cleveland). pp 138-142 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Manometers for use in the natural gas industry are described. Information is included on U type manometers, well type manometers, inclined tube manometers, absolute pressure manometers, inclined vertical pressure manometers, inclined vertical manometers, dual tube manometers and micromanometers. Factors affecting manometer accuracy are discussed along with applications. (JRD)

31972 Problems in offshore gas measurement. White, G.F. Jr. (Tennessee Gas Pipeline Co., Lafayette, LA). pp 147-149 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The design of offshore gas measuring stations is described. Transportation problems are discussed along with problems created by weather. Instrumentation and records are also discussed along with field personnel qualifications. (JRD)

31973 Gas turbine meter and continuous volume integrator. Thomas, W. (Singer Co., Philadelphia). pp 168-171 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Construction and operation of gas turbine meter-volume integrator systems are described. Turbine meter systems afford compact, accurate measurement of medium to large loads with sustained accuracy and uninterrupted service. Properly applied, they offer significant advantages in large volume gas metering. The low driving torque requirements of Continuous Integrators enable turbine meters to operate at their full capability. Equipped with available accessories, they permit transmission of corrected flow rate or corrected volume for indication and recording. (JRD)

31974 Design of distribution metering and regulating stations. McClain, W.R. (Alabama Gas Corp., Birmingham). pp 172-174 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Information required in the design of gas distribution stations is summarized. Requirements for meters, correcting instruments, regulators, safety valves, and piping and installation are outlined. (JRD)

31975 Measuring station inspection program and guide. Simpson, J.C. (Texas Gas Transmission Corp., Memphis). pp 175-176 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The purpose of an inspection program is to achieve maximum accuracy and dependability of service from a meter and regulator station. An inspection program is very effective in accomplishing this purpose. The success of such an inspection program depends upon qualified and responsible measurement personnel, proper testing equipment, and a continuing review and updating of the program.

31976 Effects and control of pulsations in gas measurement. von Nimitz, W.W. (Southwest Research Inst., San Antonio). pp 177-184 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Review of the detrimental effects of pulsations on gas flow measurement with the orifice, turbine and vortex flow meters indicates the need for effective pulsation control. The techniques for prediction and control of pulsations discussed and illustrated make it possible to design gas flow measurement facilities with the assurance of minimum uncertainty in flow measurement due to pulsation effects.

31977 Meter proof specifications relative to prover accuracy and sample testing. Bruening, N. (Singer Co., Nebraska City, NE). pp 185-188 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The bases for acceptance or rejection of gas meters are discussed. Methods of proving accuracy are reviewed and the use of statistical quality control is described. Determination of gas characteristics is discussed along with sampling plans and sampling risks. (JRD)

31978 On-line computers for custody transfer. Moring, W.W. (United Gas Pipe Line Co., Houston, TX). pp 200-203 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Computerized gas custody transfer is reviewed. Development of on-site gas flow computers is discussed along with the design of the printer-recorder. Flowsheets showing inputs used and the information generated by the computer are included along with a schematic of the entire system. (JRD)

31979 Fundamental principles of orifice meters. Colfer, R.J. (Singer Co., Philadelphia). pp 210-213 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Rate of flow type gas meters is described. The ultimate goal of any metering system is the measurement of the total quantity, or mass, of material measured during a specified period of time. Since the orifice meter indicates and records flow rate, the output of an orifice meter must be integrated to obtain the total quantity of gas measured during the specified time interval. All of the care used in the fabrication of orifice plates, meter tubes, gage lines, and measurement of pressures and temperatures is wasted unless the resulting charts are carefully and accurately integrated.

31980 Installation and operation of a densitometer. McDaniel, C. (UGC Industries, Inc., Shreveport, LA). pp 214-218 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The UGC Industries Densitometer for measuring gas density is described. Information is included on operation, installation, calibration, and maintenance. (JRD)

31981 Orifice fittings and meter tubes. Forbes, R. (Peco/Robinson, Mineral Wells, TX). pp 222-225 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman. OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Orifice fittings designed to facilitate inspection and replacement of the orifice plate in gas meters are described. Discussions are included on type E, type H, and Orifice-master orifice fittings. Fabrication of meter tubes is also discussed. (JRD)

31982 Orifice fittings and meter tubes. Darais, D.W. (Daniel Industries, Inc., Tulsa, OK). pp 226-228 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Primary components of orifice type gas measurement devices are examined. Information is included on the design and functions of senior fittings, junior fittings, and simple x fittings. (JRD)

31983 Orifice meters: operations and maintenance. Hurd, D.R. (Tennessee Gas Pipeline Co., Middleton). pp 229-233 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The operation and maintenance of a 2-pen 0 to 100" differential, and 0 to 1000 lb pressure range orifice meter are described. Information is included on selection of an orifice meter test chart, deadweight testing of static pressure elements, zero differential testing under pressure, friction testing under pressure, pen arc and pen arm tension testing, leak inspection, and calibration of the orifice meter. (JRD)

31984 Bellows-type orifice meters. Hubbard, H.A. (Singer Co., Garland, TX). pp 234-236 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The design, applications, installation, and maintenance of bellows-type orifice meters are described. (JRD)

31985 Installation, operation, and maintenance Tejas automatic chart changers. Caldwell, B.J. (Tejas Instrument Engineers, Inc., Spring, TX). pp 258-264 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Pneumatic and electric powered chart changers are described. Information is included on changer operation, power supplies, timing of chart changes, and chart plate loading. Chart changer trouble shooting guides are included in tabular form. (JRD)

31986 Fundamental principles of regulators. Becker, H.J. (Grove Valve and Regulator Co., Oakland, CA). pp 268-269 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Principles of gas regulators are discussed. Included are descriptions of regulator components such as restricting elements, power loading elements, and measuring elements. (JRD)

31987 Industrial and district regulators and applications. Loring, F.R. (Singer Co., Erie, PA). pp 270-273 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Industrial gas regulators are described. Information is included on self-operated regulators, pilot regulators, and instrument loaded regulators. Criteria for regulator selection are listed. (JRD)

31988 High and low pressure gas regulators. Kruse, J.M. (Rockwell International, DuBois, PA). pp 275-276 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Gas pressure regulators generally classified as high, intermediate, and low pressure are described. In high pressure gas regulators the attention is directed to materials of construction and design of components. Other concerns in regulator selection include regulator size, regulator rangeability, accuracy, and pressure protection. (JRD)

31989 Large capacity gas regulators. Sligh, W. (Rockwell International, Tulsa, OK). pp 277-280 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

A discussion of large capacity gas regulators is presented. Descriptions are included of balanced valve regulators, self-operated regulators, relay operated regulators, and valve designs. Regulator sizing and selection are discussed along with installation and pressure protection. (JRD)

31990 Pressure regulation and flow control with expansible tube type valves. Nalley, R.R. pp 281-284 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Expansible tube type regulators in which the only moving part is the expansible tube are described. Information is included on operating characteristics, pilot systems, pressure reduction, monitoring, relief valves, flow control, rangeability, and capacity. (JRD)

31991 Applications of telemetering systems and flow computers. Lowell, R.W. (Bristol Div. of Acco, Waterbury, CT). pp 285-288 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Types of telemetering and flow computers used in the gas industry are covered. Information is included on pulse duration modulation telemetering, variable frequency telemetering, time division multiplexing telemetering, tone multiplexing telemetering and digital telemetering. Associated flow computers are discussed. (JRD)

31992 Operation and maintenance of rubber plug type control valves. Jacobs, M. (Texsteam Products, Houston, TX). pp 289-291 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Discussions are presented on gas control valve operation, performance, installation, inspection, applications, and disassembly. (JRD)

31993 Elements of sound and sound measurement. Harper, R.B. (Florida Gas Transmission Co., Gainesville). pp 292-296 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Reduction of noise at meter and regulating stations is discussed. Information is included on noise measurement, sources of noise, gas stream turbulence removal, and noise barriers. (JRD)

31994 Application of flow computers for gas measurement and control. Keady, M.J. (Daniel Industries, Inc., Houston, TX). pp 297-298 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Electronic digital gas flow computers are reviewed. Information is included on inputs to the computer, read only memory capability, programmable read only memory capability and random access memory capability. Discussions of supercompressibility calculations, flow control, tube control, and calibration are also included. (JRD)

31995 Application and operation of ball valve regulators. Becker, R.J. (Becker Precision Equipment, Inc., Elk Grove, IL). pp 299-301 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Ball valve regulators are capable of control equal to any regulator and generally offer longer time periods before requiring maintenance. Today, they are the most suitable for use in buried service and have the largest capacity for a given size. With all these features and using the economics the buried units offer, it is believed that this is the best type regulator for pressure, flow, surge control, and relief valve service.

31996 Fundamental principles of pilot control. Loring, F.R. (Singer Co., Erie, PA). pp 302-305 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Pilot (relay) type operated gas pressure regulators are reviewed. Information is included on self-operated regulators, pressure loading, pilot operation, and instrument loading. (JRD)

31997 Expansible element valves for pressure regulation and relief. Hubbard, H.A. (Singer Co., Garland, TX). pp 306-308 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Construction, operation, and applications of expansible element gas valves are described. (JRD)

31998 Turbulence and its effect in measuring and regulating stations. Welker, R.H. (Welker Engineering Co., Bellaire, TX). pp 309-311 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The noise potential in regulating stations is assessed and analyzed. Photographic methods of studying turbulence are described. Turbulence and impingement in pressure regulators are considered along with down-stream piping. It is noted that down-stream pipes and headers should conform as closely as possible to the shape of the expanding gas. (JRD)

31999 Meter station noise forecasting. Gardner, J.R. (Fisher Controls Co., Marshalltown, IA). pp 312-316 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Techniques of predicting noise levels at gas regulating stations are discussed. Federal requirements on noise maximum values are cited and formulas for noise prediction are derived and illustrated. (JRD)

32000 Relief valves. Broaddus, D. (Anderson, Greenwood, and Co., Bellaire, TX). pp 317-320 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Development and operation of the modulating mode gas relief valve are described. The valve is designed to deliver only the volume of gas required for overpressure relief. (JRD)

32001 Principles, application, and sizing of monitor regulators. Hughes, G.C. (Sprague Meter Co., Bridgeport, CT). pp 321-330 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Gas service regulators and monitors are examined. Information is included on downstream monitors, up-stream monitors, series regulation with monitor takeover, single valve body monitors incorporating dual regulator and dual relief, single valve body monitors incorporating single monitor and single regulator, single valve body monitors incorporating single diaphragm relief, and single valve body monitors incorporating monitor and relief. (JRD)

32002 Maintenance and trouble shooting of LACT units. Coffelt, D.E. (Continental Oil Co., New Orleans). pp 331-335 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The basic function of each lease automatic custody transfer (LACT) component is reviewed with attention focused on the maintenance required to assure that each function is performed successfully. Failure of individual components to perform their function generally results in a recognizable set of symptoms that can be used as troubleshooting guidelines. Basic considerations in both LACT maintenance and troubleshooting that have been found effective are presented.

32003 LNG densities for custody transfer. Albright, M.A. (Phillips Petroleum Co., Bartlesville, OK). pp 374-377 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Methods of LNG custody transfer accounting are described using flowsheets. The importance of accuracy is shown. It is noted that data on which to base calculated densities for use in densimeter calibration are being measured at the NBS cryogenic laboratory for distribution throughout the industry. (JRD)

32004 Installation, operation, and maintenance of Mullins automatic chart changers. Howard, R.L. (Mullins Manufacturing Co., Inc., Dallas). pp 391-392 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Design and operation of the Dial-O-Graph is described. This device is designed as a labor saving device to automatically change record charts at a predetermined time. (JRD)

32005 Determination of leakage and unaccounted for gas. Powell, J.J. Jr. (Mississippi Valley Gas, Jackson). pp 419-421 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Unaccounted for gas in distribution systems is discussed. While any difference between input and output can be considered unaccounted-for, the "real" unaccounted-for is of primary concern. Real unaccounted-for is leakage and measurement error. Leakage is of concern because of the hazard involved and the cost of the loss of purchased gas. Measurement error is of concern because of the cost of gas paid for and not sold. The determination of "real" unaccounted-for is a system by system problem. The methods and procedures for determination must be adapted to fit the system and the specific set of circumstances current. Many times the best that can be accomplished is a comparison of the current year's unaccounted-for with preceding years, on the assumption that the effect of billing lag remains constant and that an increase in total unaccounted-for indicates an increase in "real" unaccounted-for. However, an understanding of the system load characteristics and the conditions prevalent during the time period considered is an absolute necessity.

32006 Advanced applications of telemetering systems and flow computers. Schwartz, R.F. (Bristol Div. of ACCO, Waterbury, CT). pp 427-432 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Digital telemetry incorporating gas flow computers is discussed. Information is included on data reduction, binary number systems, serial/parallel outputs, unidirectional scanners, scanner applications, and bi-directional systems. (JRD)

32007 Servo driven oval gear meters. Takada, A. pp 440-448 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The Oval High Pressure Gas Flowmeter, Model SFG, allows for the precision measurement of gas flow by volumetric method. It is characterized by predictable performance regardless of pressure, density, or viscosity of gas being handled; negligible pressure loss (approximately 1 mm water column); linear calibration over wide flow range; and analog or digital transmission signals.

32008 Fundamentals of gas turbine meters. LaNasa, P.J. (Daniel Industries, Inc., Houston, TX). pp 449-453 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Principles of operation, construction, and performance of gas turbine meters are described. Information is included on meter capacity, effects of gas density, field testing, and transfer proving. (JRD)

32009 Meter shop design, equipment, and techniques. Juckes, J. (Southern Union Gas Co., Belen, NM). pp 457-458 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

An assembly line type gas meter maintenance shop is described. A shop must be designed for individual needs. One good approach would be a straight line schematic on a string of beads which could be coiled and looped onto various floor plans. Another valuable tool is paper dolls or provers, benches, etc. which can be shuffled on floor plans. Eliminate as many permanent partitions as possible so that furniture may be easily rearranged for future needs.

PROPERTIES

32010 Method for predicting thermodynamic properties of natural gas at low temperature. Barsuk, S. (Research Inst. of Natural Gases, Moscow). pp LNG-4, Addendum 1 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Method for predicting thermodynamic properties of natural gas by means of a modified Redlich-Kwong equation of state is suggested. Comparison of the results predicted for the vapor-liquid equilibrium and enthalpy with the experimental data for the low temperature separation and natural gas liquefaction is also presented.

32011 Thermal energy measurement. Caldwell, B.J. (Tejas Instrument Engineers, Inc., Spring, TX). pp 13-15 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Analytical information is presented to show that empirical equations may be used advantageously to meter gases in thermal energy units, within tolerances not bettered elsewhere in the metering area. These equations are equally adaptable to older equipment or modern computer techniques. (JRD)

32012 Specific gravity instruments: care and operation. Dunn, L.W. (Arcco Instrument Co., Inc., Los Angeles). pp 72-73 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Aspects of care and operation are discussed for instruments and devices including the Arcco-Anubis Gas Gravitometer, the Arcco LPG Densitometer-Gravitometer, the Arcco-Anubis Gravitometer Prover, and the Arcco Gas Sampler. (JRD)

32013 Test instruments and recorders for specific gravity. Kahmann, A.R. pp 74-77 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Instruments used to measure the specific gravity of natural gas are described. Information is included on gravity balances, the reading balance, recording gas gravimeters, and the AC-ME recording gas gravimeter. (JRD)

32014 Determination of water vapor content and hydrocarbon dew point in natural gas. Laughlin, A.R. (Transcontinental Gas Pipe Line Corp., Houston, TX). pp 95-98 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Methods are described for determining the water content of natural gas using gravimetric train systems, and by testing for visual dew point incorporating data based on the vapor pressures, percent of saturation, and dew point. Discussions are included on the thermodynamics of moisture content, instruments for measuring water content, and hydrocarbon dew point.

32015 Kinetic type indicating and recording instruments for determining specific gravity. Leslie, F.B. (Permutit Co., Inc., Paramus, NJ). pp 125-130 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Operation, installation, testing, and maintenance of instruments for recording and indicating natural gas specific gravity are described. (JRD)

32016 Technical session, specific gravity instruments installation, and operation. Bozeman, J.C. (UGC Industries, Inc., Shreveport, LA). pp 160-1067 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Specific gravity instruments for natural gas are described. Emphasis is placed on the UGCI recording gravitometer. The gravitometer may be equipped with a complete line of accessories. 24-hour, 7-day, or 72-hour rotations with electrical or key-wind chart drives are available. Charts are changed automatically and stored in chronological order when the instrument is equipped with chart changer. With the recent design of the new UGCI Angular Transducer system a new dimension is added to the versatility of the UGCI Gravitometer. The extreme accuracy of the analog output signals makes the UGCI recording Gravitometer a highly important tool for the gas industry in the measurement and calculation of volume, dekatherm energy calculations, and is highly adaptable to specific gravity control loops. Under any climatic extreme, the all-mechanical UGCI Gravitometer automatically and continuously measures specific gravity for use in gas measurement. It is easily operated and maintained. No controlled or conditioned atmosphere is required. (JRD)

32017 Moisture titrators. Nicewarner, I. (UGC Industries, Inc., Shreveport, LA). pp 189-191 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Operation of water vapor metering devices for gases is reviewed. Titrators involving the use of Karl Fischer reagent are emphasized. (JRD)

32018 Bellows type orifice meters. Ballou, W.D. (ITT Snyder, Oklahoma City). pp 219-221 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Liquid filled, dual bellows differential pressure gas flowmeters are described. Information is included on design, construction, operation, and maintenance. (JRD)

32019 Basic devices and techniques for supervisory control and telemetry systems. Goering, J.R. (Furlow and Associates Engineering Co., Tulsa, OK). pp 237-240 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Techniques and hardware used in pipeline supervisory control and telemetry systems at remote stations and dispatch centers are described. The successful operation of a supervisory control and telemetry system depends largely upon the reliability and performance of the individual devices within the system. Each system contains unique features. However, systems manufacturers, through gaining a better understanding of dispatching requirements, have developed a series of standard hardware and software modules that have proven reliability yet provide flexibility. Improvements in solid state technology and development of new techniques not only enable use of programmable remote stations but also provide the dispatcher with a wide variety of interactive functions with the dispatch center equipment. These continuing improvements in equipment and techniques provide for a safer and more efficient pipeline system operation.

32020 Sonic nozzles for gas meter calibration. Britton, C.L. (Flow Measurement Systems, Fort Collins, CO). pp 241-244 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Sonic nozzles have been used in the laboratory for gas meter calibrations for several years. However, it has been only recently that sonic nozzles have been used to calibrate gas meters in the field. Information is given on sizing, installation, and proper usage of sonic nozzles for field calibrations of gas meters.

32021 Determination of hydrogen sulfide and total sulfur by titration methods. Austin, R.R.; Robison, J.R. (ITT Barton, Monterey Park, CA). pp 250-257 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Electrolytic generation of bromine as a titrating reagent for measurement of sulfur compounds in the gaseous phase was introduced to industry nearly twenty years ago. With the development of transistor electronics and the discovery of a practical coulometric bromine sensing electrode system, a new, wide range electrolytic titrator was developed and designed to meet the specific requirements for continuous sulfur monitoring.

32022 Liquefied natural gas: operations and measurement. Campbell, K.C. (Phillips Petroleum Co., Bartlesville, OK). pp 353-356 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Operation of the Kenai, Alaska LNG plant is described. The Kenai LNG project has been successful by delivery performance and on-stream time criteria. The project efficiency has been increasing since start-up and delivered volume currently exceeds 81% of plant inlet gas. Without the design provisions and plans for measuring significant elements of performance, there would have been little prospect for recognition of opportunities to improve. Measurement provisions for all LNG projects are important and will become more so with increasing energy values. Capital outlays for measurement equipment that would have been uneconomical in recent years are now practical, even mandatory, for sound project management. Those involved in LNG measurement are faced with challenges to meet the industry's demand for processing and transporting LNG energy with accurate accounting and peak efficiency.

32023 Applications of densitometers to fluid measurement. November, M.H. (ITT Barton, Monterey Park, CA). pp 361-365 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The density of a fluid is an important physical property. A knowledge of fluid density is vital to a broad spectrum of measurements in fluid mechanics. In fluid flow measurement, an exacting knowledge of flowing density is primary to the precise metering of volume and mass flow. The mass of a combustible fluid bears a close correlation to its intrinsic calorific content, i.e., heat of combustion. Accordingly, mass measurement is significant in current trends to therms metering. Other areas of application for densitometers are discussed.

32024 Gas chromatography. Mathews, R.G.; Pedro, N.A. (Pennzoil Co. Research Lab., Shreveport, LA). pp 385-390 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

The gas chromatographic analysis of natural gas is discussed as currently performed at the Pennzoil Company Research Laboratory and the adjacent United Gas Pipe Line Company facility. Instrumentation, techniques, and treatment of data are described.

COMBUSTION

REFER ALSO TO CITATION(S) 31919, 31920, 31921, 32731, 32766, 33056

32025 Noise generation of gas flames due to feedback excited oscillations . Riley, J. (Purdue Univ., West Lafayette, IN); Goldschmidt, V.W.; Leonard, R.G.; Baade, P.K. pp 20p., Session III, Paper 5 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

The transfer function of the flame is useful information in testing the stability of combustion systems subject to feedback excited oscillations. An experimental study is reported in which a sinusoidal volume disturbance (variable in frequency and amplitude) is imposed on an air-LP gas mixture before combustion on a Meker burner. Changes in the amplitude and phase of the sinusoidal disturbance were studied using microphones upstream and downstream of the flame, a hot wire anemometer upstream of the flame, and a photomultiplier. Using the data from this equipment, transfer functions for the flame were found for frequencies from 40 to 600 hertz for a series of five air to fuel ratios.

32026 Installation and operation of recording calorimeters. Kersey, A.F. pp 78-82 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Installation and operation of tank type and electronic calorimeters are summarized. Service and maintenance of these devices is outlined. (JRD)

32027 Recording calorimeters installation and testing. Gabel, G.C. (Houston Pipe Line Co., TX). pp 143-146 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

Construction, operation, installation, maintenance, and testing of recording calorimeters are described. Information is included on temperature effects and proper air-gas ratios. (JRD)

STORAGE

REFER ALSO TO CITATION(S) 31923, 31939, 31943, 31944

32028 LNG tank stratification consequent to filling procedures. Smith, K.A.; Germeles, A.E. (Cabot Corp., Boston). pp 21p., Session

IV, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Large LNG storage tanks are capable of exhibiting, apparently spontaneously, exceedingly large and unexpected over-pressures which in turn create very large venting rates. It is commonly believed that such undesirable events are due to tank "roll-over." Heretofore, a major obstacle to quantitative roll-over predictions, eg., venting rates, has been the lack of a well-posed initial condition. In particular, it has not been possible to specify the density vs. height profile which would exist in an LNG tank upon completion of the transfer of cargo which is of a density different from that of the tank inventory. Results from both an experimental program, which used model fluids in a small tank, and a computer simulation of the hydrodynamic mixing process during the cargo transfer are presented. It is shown that the experimental and computed density profiles are in good agreement with each other, and that the initial density profiles of LNG tanks are therefore susceptible to prediction.

32029 LNG storage tanks for metropolitan areas. Schuller, M.R. (Pittsburgh-Des Moines Steel Co., Pittsburgh); Murphy, J.C.; Glasser, K.F. pp 9p., Session VI, Paper 3 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

It is the desire of gas companies and/or governing officials in some large Metropolitan areas to have incorporated in their LNG storage facility the containment safety feature provided by In-Ground Storage. This need can be satisfied by designing their above ground double-walled metal storage tank having all penetrations through the roof and surrounded by a 10 foot thick concrete wall. A three-mode level of containment safety can be attained by designing all three, the inner tank, the outer tank, and the concrete wall, as containers for the LNG. The forementioned features are a part of the 290,000 bbl LNG Storage Tank built by PDM for Consolidated Edison Company of New York, Inc. located in Astoria, Queens, New York City. Particular elements of this tank are discussed with emphasis being given to the aspects related to safety.

32030 Determination of storage capacities in an LNG terminal. Vincent, R. (Techniques Nouvelles Appliquees, Villejuif, France). pp 26p., Session VI, Paper 4 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The functions of LNG marine terminals are discussed. Principles and conclusions of a study based on simplified assumptions of random-delayed arrivals for methane ships at an LNG terminal are presented. These delays are represented by a cumulative probability distribution curve function of time. The corresponding risks of gas emission failure can be faced by using a reserve storage up to the level of risk which can be allowed in the terminal facility. Relations between the LNG delayed reception cost, i.e., the gas emission failure costs for the terminal, and the costs of marginal reserve storages are established. The relations can be used, at least on a theoretical basis, in order to select economical criteria for choosing the storage capacities.

32031 Eight years of experience with underground storage of LNG. Bendani, A. (Camel, Arzew, Algerie). pp 12p., Session VI, Paper 5 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974). (In French)

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

The LNG plant of Arzew has in addition to its three above ground storage tanks an underground storage tank (Frozen Hole) of 38,000 m^3 design capacity and of an operating capacity reaching up to 37,000 m^3. Its construction lasted two years and it has been in operation for eight years. This type of storage is not specific to an LNG plant only. It can also be of interest to LNG buyers at LNG terminals as well as distributors of natural gas inland as seasonal storage. The choice of this type of storage is made on the basis of initial cost and safety. Aspects of its construction, the conditions of its operation, and results of its operation are reviewed.

32032 Storage system at LNG receiving terminal for Brunei LNG project. Yoshida, K. (Tokyo Gas Co., Ltd.). pp 10p., Session VI, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Tokyo Gas and The Tokyo Electric Power have agreed to receive Brunei LNG supplies jointly to maximize both companies receiving capacity. That is, by operating the receiving tanks jointly, it is possible to reduce total tank capacities to half of that which would have to be installed had separate ownership continued. It has also been possible to minimize capital investment in storage tanks by virtue of adjustments in the differences of consumption patterns by the two companies. In addition, full use is made of auxiliary storage tanks to cope with irregular calls by tankers. To ensure complete safety in operation of these tanks, Tokyo Gas and The Tokyo Electric Power have jointly adopted an on-line real time LNG control data processing system; the major feature of this system is the simulation of the movements of the LNG tankers. The input data is provided by Coldgas Trading Company, the seller of Brunei LNG, but the programming has been developed solely by Tokyo Gas; the great advantages of this system lie in the ability to determine the capacity of the required tankage.

32033 Environmental and safety aspects of LNG storage. Walters, W.J.; Dean, F.E.; Carne, M. (British Gas Corp., London). pp 17p., Session VI, Paper 7 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

Factors which must be considered when finding a site, planning and obtaining permission for a new LNG storage installation are examined. Environmental aspects of site selection are considered. The U.K. planning procedures are described, including the processes of consultation with local authorities, Government departments, and the general public. The design considerations relating to the appearance of the plant are discussed, with emphasis on the importance of treating each site in a sympathetic and individual manner. Safety aspects of plant design are considered. The problems posed by the storage tanks are particularly important. Steps which can be taken to reduce the likelihood and consequences of accidental LNG escape are described. The principles by which these sometimes conflicting demands are resolved are outlined.

32034 Development of insulation systems for large capacity double walled metallic LNG storage tanks. Dodd, P.; Todd, G. (Whessoe Limited, Darlington, Eng.). pp 27p., Session VI, Paper 8 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

In the design of large capacity LNG storage tanks safety is of paramount importance and it is therefore necessary to have a full understanding of the properties of component materials under the specific operating conditions. In the case of the insulation materials, these are generally conventional products which are being used in an unconventional environment so that extensive development work is necessary to substantiate their use. The design basis and results of development work on base, shell, and roof insulation systms relating to the construction of 2—50,000 m^3 tanks are presented. In particular, results of an extensive program of ambient and low temperature tests on the load bearing characteristics of foamed glass and lightweight concrete blocks are given, together with the design basis for calculating the horizontal pressure developed by a Perlite/glass fiber blanket wall insulation system due to thermal cycling of the inner tank. Details are included for the substantiation of the use of plywood panels for the suspended inner roof. Information is given on problems associated with thermal design and the thermal performance calculations have been substantiated by obtaining operating data from a 12,000 m^3 installation. An outline design is given for a 100,000 m^3 tank with indications of future trends of development work.

32035 Operations and measurement in base load LNG terminals. Christian, W. (Southern Natural Gas Co., Birmingham, AL). pp 454-456 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

LNG terminals for delivery of gas from Algeria to the US are described. Information is included on base load vs peak shaving, instrumentation and control, and measuring methods. Conscientious operation of a base load LNG plant is essential due to the intricacies involved with handling such large volumes of liquid. Process control of a base load plant is not complicated. The material cost for the analog instrumentation and digital computer is only 3.3 percent of the project material cost excluding the storage tanks and unloading dock. Measurement and analysis of LNG at large flow rates is

presently not available in the accuracies required by the industry. The Research and Development programs presently under way should provide a solution to this problem. (JRD)

32036 High pressure farm taps and service regulators. Day, D. (Fisher Controls Co., Marshalltown, IA). pp 284 of In Proceedings of the fifty-first International School of Hydrocarbon Measurement. Norman, OK; Univ. of Oklahoma (1976).

From 51. International School of Hydrocarbon Measurement conference; Norman, Oklahoma, United States of America (USA) (13 Apr 1976).

See CONF-760498—.

High pressure farm tap and service regulators are the most simple in construction and the most basic regulator utilized in the gas industry. To achieve optimum performance, these regulators must be properly applied and properly sized. A thorough knowledge of the construction features and principles of operation is essential. The one basic consideration to pay particular attention to is the orifice size.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 32704

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 31795, 31889

DRILLING, FRACTURING, AND MINING

32037 Hydraulic mining technique for recovering bitumen from tar sand deposit. Redford, D.A. (to Texaco Exploration Canada Ltd.). US Patent 3,951,457. 20 Apr 1976. Filed date 7 Dec 1973. 10p.

Viscous petroleum including bitumen may be recovered for subterranean petroleum containing unconsolidated said formations such as tar sand deposits by hydraulic mining. Hot water or steam is introduced into the subterranean deposit with sufficient velocity to dislodge bitumen and particles of sand therefrom. The process is a single wellbore operation using rotatable vertically moveable injection string with one or more jets near the bottom thereof, with separate return flow path to surface, the inlet to which may be on the bottom of the injection string. Injection string may be raised or lowered while rotating and jetting so full vertical thickness of tar sand interval is contacted by aqueous mining fluid. Jet pump may be used to pump petroleum to surface. Injected aqueous hydraulic mining fluid may contain alkaline material such as sodium hydroxide or ammonium hydroxide. Non-condensable gas is introduced under pressure to assist in supporting overburden weight, to assist in pumping operation and to provide gas filled cavity so jets reach deep into formation, and to aid in surface separation of bitumen from the produced aqueous pulp. 22 claims, 1 figure.

32038 Method of removing tar sands from subterranean formations. Lambly, C.A.R.; Draney, C.T. US Patent 3,957,308. 18 May 1976. Filed date 8 Nov 1974. 8p.

Hydraulic mining of tar sands in a formation wherein water is introduced into a plurality of spaced cavities in the bottom of a tar sands formation and above a number of tunnels communicating with respective cavities by openings is described. In one embodiment of the method, water is sprayed onto exposed tar sands surfaces in the cavity and further creates a moist atmosphere in those regions of the cavity where the water is not directly sprayed on the surfaces. The moist atmosphere can be in the form of suspended water droplets or can be saturated water vapor at a temperature above the ambient temperature of the tar sands or a combination of both. The water on the exposed surfaces penetrates the formation along paths of preferential wetability, causing adjacent portions of the formation to separate and break loose from the formation itself in a direction in which the portions are free to expand. This separation enlarges each cavity and the separated tar sands portions eventually disintegrate and become loosened tar sands by the continued presence of the water spray and the moist atmosphere. Heat can be introduced in the form of steam or by heating the incoming water, and the heat accelerates the separation of the formation and the disintegration of the tar sands portions. The disintegrated tar sands are slurried in water with the aid of one or more water jets or by other suitable mechanical action, and are removed as a slurry by gravity flow from each cavity. 20 claims, 4 figures.

32039 Longwall mining system and archshield for mining tar sands, oil shales and the like. Johns, R.W. (to World Oil Mining Ltd.). US Patent 3,958,830. 25 May 1976. Priority date 18 Mar 1974, Canada. 20p.

In the underground mining of friable mineral deposits such as bituminous sands, method and apparatus are disclosed in which a working crosscut in the mineral deposit is established, connecting two parallel operating tunnels, the front wall of the crosscut being unsupported and forming the mining wall, the roof and rear wall of the working crosscut being separated from the mining equipment by a novel mining shield comprising a plurality of forwardly inclined, base supported arch members positioned in adjacent abutting relationship and each independently advanceable towards the mining wall. A conventional mining machine is employed under the mining shield in the working crosscut, operating across the full width of the mining wall. As the mining machine removes a cut, apparatus upon the mining machine advances individual mining arch sections forwardly into the mining face and the depth of the cut, leaving the backs unsupported and free to collapse behind the advancing mining shield. The procedure continues until a blocked-out section of the mineral deposit is traversed. The mining operation is successively repeated in the collapsed mineral material until the mineral deposit is mined out. 32 claims, 23 figures.

OIL PRODUCTION, RECOVERY, AND REFINING

32040 Preliminary studies on the recovery of oil from Chattanooga shale. Herrell, A.Y. (Knoxville Coll., TN); Arnold, C.J. *Thermochim. Acta;* **17**: No. 2, 165-175(Nov 1976).

Three exploratory investigations were performed to examine the recovery of oil from the Chattanooga black shale formation. Thermogravimetric data were analyzed to yield an average activation energy of 57.1 kcal mol^{-1} for the conversion process; positive deviations from a reaction order of 3.7 were observed suggesting the presence of autocatalytic effects at low conversion levels. Thermal chromatographic analysis indicated that the maximum organic product release occurred at approximately 435°C and resulted in an oil of relatively low distillation range. A packed bed of shale was retorted in the self-sustained combustion mode thus suggesting the feasibility of this mode for in situ oil recovery. Comparisons with oil shale from Colorado's Green River formation have been made throughout.

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 31819, 32037

32041 Bitumen upgrading: its importance to the in-situ producer. Simmer, M.; Thompson, D.C. pp 12p., Paper 7602 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

This paper explores the substantial effect on the producing operation of the selection and design of upgrading and utilities plants in an in-situ oil sands scheme. Oil sands bitumen contains large amounts of impurities which have to be removed in converting (upgrading) to synthetic crude. This upgrading increases the hydrogen-carbon ratio and removes the sulfur and nitrogen present in the crude bitumen. There are a number of processes that are suitable for bitumen upgrading. Several of the most promising processes are described, including schematic process flow diagrams and yield slates. The energy requirements of such an integrated producing-upgrading-utility complex are immense but can be significantly reduced by complete process integration of the facilities. Among the major energy consumers in the upgrading-utility complex are the hydrogen plant and electric power generating equipment. The nonlinear relationship of conversion (upgrading bitumen feed to synthetic crude) to overall (produced bitumen to synthetic crude) recovery is demonstrated by two examples of the same process. Economic factors are examined qualitatively in the last part of this paper.

32042 Field test of reverse combustion oil recovery from a Utah tar sand. Land, C.S.; Cupps, C.Q.; Marchant, L.C.; Carlson, F.M. (Energy Research and Development Administration, Laramie, WY). pp 8p., Paper 7603 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

A field experiment to recover oil from tar sand by reverse combustion was conducted at Northwest Asphalt Ridge, near Vernal, Utah. This test was in a 10-foot interval of the Rim Rock sandstone member of the Mesa Verde Formation at a depth of approximately 300 feet. Ignition was accomplished November 25, 1975, and the reverse combustion front was propagated successfully through the formation. Results of the field experiment differed significantly from the results of laboratory tests that were used in the design of the field test. This difference is attributed primarily to the

extreme heterogeneity of the tar sand formation. Observed temperatures in the burned area were lower than expected, but a large portion of the tar sand within the pattern boundaries was heated to the extent that the bitumen became mobile enough to be produced. After 3½ weeks of operation, the project was terminated because of the inability of the surface production equipment to accommodate the heavy hydrocarbons being produced. Although the formation of the cracked products of reverse combustion was less than expected, this recovery process may be used successfully to heat the tar sand reservoir to a temperature high enough that the bitumen becomes mobile enough to be produced.

32043 Fireflooding shallow tar sands: a case history. Terwilliger, P.L. (Gulf Research and Development Co., Pittsburgh). pp 11p., Paper 7608 of In CIM/CSPG convention on enhanced recovery. Calgary, Alberta, Canada; Gulf Oil Canada Ltd. (1976).

From CIM/CSPG convention on enhanced recovery; Calgary, Canada (7 Jun 1976).

See CONF-760676—.

A field pilot test of forward combustion utilizing fracturing techniques was conducted in a shallow tar sand deposit in central Kentucky. The tar sand at a depth of 100 ft had an average porosity of 22%, an oil saturation of 64% (6.4% tar by weight) and a permeability after extraction of about 2000 md. The tar had an API gravity of 10.4° and a viscosity of 150,000 cps at a reservoir temperature of 56°F. The pilot area was a small inverted five-spot 107 ft on a side. Horizontal fractures were created in the four producing wells by breaking down the formation with air pressure, and these fractures propped to a calculated radius of 25 ft by injecting water-base gel carrying 4 to 8 mesh sand. A pneumatic fracture was created in the central injection well which was held open by the continued injection of air. A down-hole burner was used to initiate the combustion zone. Oil production responded to the movement of the combustion zone ten days after the fireflood was started. The average oil production was 24 barrels per day for the four months required to complete the test. The total oil production of 3100 barrels was 54% of 5700 barrels originally in place in the pattern area. The injected air-produced oil ratio was 42,000 cu ft/bbl. The produced oil was upgraded to 14.5°API and 2000 cps at 60°F compared to 10.6°API and 90,000 cps for the original tar at the same temperature. The majorproblems encountered were the lack of complete oxygen consumption, the unsymmetrical advance of the fire-flood and the tendency of the combustion zone to move toward the top of the reservoir.

32044 In situ recovery of hydrocarbons from tar sands. Barry, C.B. (to Ralph M. Parsons Co.). US Patent 3,945,435. 23 Mar 1976. Filed date 7 Nov 1974. 10p.

Hydrocarbon products from viscous tar sands are recovered by continuously injecting a hot solvent containing relatively large amounts of aromatics into the formation. Alternatively, steam and solvent are cyclically and continuously injected into the formation to recover the values. The last stimulation is by steam so that solvent is recovered. A third alternative is to continuously inject a mixture of steam and solvent vapors and liquid into the formation. In all cases, the solvent, except perhaps for startup, is produced at the site, as in a conventional topping unit, which alternatively is combined with a conventional visbreaking or reforming unit to increase the volume and/or aromaticity of the solvent produced.

32045 In situ recovery of hydrocarbons from tar sands. Barry, C.B. (to Ralph M. Parsons Co.). US Patent 3,946,810. 30 Mar 1976. Filed date 7 Nov 1974. 10p.

Hydrocarbon products from viscous tar sands are recovered by continuously injecting a hot solvent containing relatively large amounts of aromatics into the formation. Alternatively, steam and solvent are cyclically and continuously injected into the formation to recover the values. The last stimulation is by steam so that solvent is recovered. A third alternative is to continuously inject a mixture of steam and solvent vapors and liquid into the formation. In all cases, the solvent, except perhaps for startup, is produced at the site, as in a conventional topping unit, which alternatively is combined with a conventional visbreaking or reforming unit to increase the volume and/or aromaticity of the solvent produced.

32046 Production of bitumen from a tar sand formation. Perkins, T.K. (to Atlantic Richfield Co.). US Patent 3,958,636. 25 May 1976. Filed date 23 Jun 1975. 10p.

A method is described for producing bitumen from a subterranean tar sand formation while heating the formation via electrical conduction between a plurality of wells completed therein characterized by a plurality of steps. First, a high back pressure is maintained on the wells. Next, an immiscible fluid is injected into the formation through one of the wells. Thereafter, the bitumen is produced through one of the wells.

32047 Production of bitumen from tar sands. Striegler, J.H.; Howell, E.P. (to Atlantic Richfield Co.). US Patent 3,986,557. 19 Oct 1976. Filed date 6 Jun 1975. 4p.

A multi-step process is described for producing bitumen from a subterranean tar sand formation. First, a continuous wellbore, having a second section contained within the formation and a first and a third section extending the second section to the earth's surface, is formed. Next, a perforated liner is inserted into the wellbore extending the entire length, and having perforations so positioned as to be adjacent to the second section of the wellbore. A heated fluid is circulated through the wellbore, contacting the formation via the perforations, thereby reducing the viscosity of the bitumen contained therein, rendering it mobile. Subsequently, the mobilized bitumen is recovered via the wellbore. (JGB)

32048 Thermal recovery of hydrocarbons from tar sands. Cram, P.J.; Redford, D.A. (to Texaco Exploration Canada Ltd.). US Patent 3,993,132. 23 Nov 1976. Filed date 18 Jun 1975. 6p.

A method is described for the recovery of low API gravity viscous oils or bitumen from a subterranean formation by the injection of a mixture of an oxygen-containing gas and steam having an optimum gas/steam ratio that is decreased as the cumulative amount of steam is increased. 10 claims, 1 figure.

32049 Recovering viscous petroleum from thick tar sand. Anderson, D.J.; Kirkvold, C.F.; Pisio, P.; Lishman, J.R. (to Chevron Research Co.). US Patent 3,994,341. 30 Nov 1976. Filed date 30 Oct 1975. 8p.

Recovery of viscous petroleum such as from thick tar sands is assisted using a closed-loop flow path from the earth's surface through a substantial portion of the formation for conducting hot fluid to reduce the viscosity of the petroleum in the formation to develop a potential passage in the formation outside the flow path into which a drive fluid is injected to promote movement of the petroleum to a production position.

32050 Method of recovery of bitumen from tar sand formations. Paull, P.L.; Armistead, F.C. (to Texaco Development Corp.). US Patent 4,003,432. 18 Jan 1977. Filed date 16 May 1975. 8p.

A competent permeable communication zone is described connecting injection and production wells completed in a tar sand which communication zone will be rigid and will not tend to slump or heal may be developed by injecting a fluid in the injection well under such pressure so as to fracture the tar sand formation between the injection well and the production well and circulating a fluid between the injection and production wells which is at a temperature sufficiently low to freeze the water in tar sands. The fluid may contain propping agents to hold the fracture surfaces apart. This procedure will rigidify the hydrocarbon portion of the tar sand formation in the vicinity of the fracture zone as well as freeze the water in the tar sand formation. Once the fracture is established a solvent for the hydrocarbon in the tar sands may be circulated preferably at a temperature below the freezing point of the water in the tar sands to extract the bitumen therefrom. 12 claims.

SURFACE METHODS

32051 Conversion of oil shale by controlled hydrogasification. Schora, F.C. Jr.; Feldkirchner, H.L.; Tarman, P.B.; Weil, S.A. (Institute of Gas Tech., Chicago). pp 11p., Session IV, Paper 2 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

A new process has been developed for converting oil shale to pipline gas by direct hydrogasification. This process uses countercurrent shale/hydrogen contacting and excess hydrogen. Laboratory- and bench-scale tests have demonstrated that as much as 95 percent of the organic matter in the shale can be converted to useful products. Along with the results obtained thus far, the design of a 1 ton per hour process development unit is discussed as well as commercial process concepts.

32052 Hydroseparation process for aqueous extraction of bitumen from tar sands. Anderson, J.C. (to Great Canadian Oil Sands Ltd.). US Patent 3,951,779. 20 Apr 1976. Filed date 21 Oct 1974. 6p.

A method is described for improving recovery in a hot water process for extracting bitumen from tar sands comprising adding bitumen-depleted middlings recovered from a scavenger zone to the sand layer in a primary extraction vessel at a point below the surface of the sand. 6 claims, 1 figure.

32053 Method of separating bitumen from bituminous sands and preparing organic acids. Willard, J.W. Sr. (to CAW Industries, Inc.). US Patent 3,951,778. 20 Apr 1976. Filed date 26 Mar 1974. 18p.

Bituminous sands are intimately contacted with an aqueous medium containing a catalytically effective amount of a novel catalyst to separate the bitumin at temperatures below the decomposition point of valuable hydrocarbons contained therein. Usually the temperatures of separation are not higher than 100°C and preferably are

about 40°-90°C. The catalyst used in practicing the present invention may be prepared by steps including admixing a water soluble alkali metal silicate with an aqueous medium containing carefully controlled amounts of dissolved water soluble substances which are sources of calcium ion and magnesium ion, reacting the same to produce an aqueous colloidal suspension of the reaction product, admixing a micelle-forming surfactant with the aqueous medium, and agitating the aqueous medium containing the colloidal particles and surfactant to form catalyst containing micelles. 28 claims.

32054 Vessel for extracting bitumen from tar sands. Davitt, H.J. (to Sun Oil Co. of Pennsylvania). US Patent 3,954,415. 4 May 1976. Filed date 21 Oct 1974. 8p.

An improved separation cell suitable for use in a hot water method for extracting bitumen from tar sands is described. The improvement lies substantially in the hollow inverted frusto-cone shaped bottom of the cell having a means for injecting hydroseparation liquid into the cavity formed by the frusto-conical bottom. 6 claims, 2 figures.

32055 Multiple solvent heavy oil recovery method. Allen, J.C.; Woodward, C.D.; Brown, A.; Wu, C.H. (to Texaco Inc.). US Patent 3,954,141. 4 May 1976. Filed date 3 Feb 1975. 12p.

Petroleum may be recovered from viscous petroleum-containing formations including tar sand deposits by injecting into the formation a multiple-component solvent for the petroleum. At least one solvent component is gaseous at the temperature and pressure of the petroleum reservoir such as carbon dioxide, methane, ethane, propane, butane or pentane and at least one component is liquid at the reservoir conditions, such as hexane and higher molecular weight aliphatic or aromatic hydrocarbons. The multiple solvent is preferably introduced under sufficient pressure that it is substantially all in the liquid phase. Recovery of petroleum and solvent may be from the same well as is used for injection or from a remotely located well. When the pressure in a portion of the formation contacted by the solvents is reduced below the vapor pressure of the gaseous solvent, it vaporizes to provide drive energy for oil production. The liquid components dissolve in the petroleum and reduce the petroleum viscosity. 21 claims.

32056 Apparatus for separating organic material from particulate tar sands and coal and agglomeration of the particulate residue. Meadus, F.W.; Sparks, B.D.; Puddington, I.E. (to Canadian Patents and Development Ltd.). US Patent 3,984,287. 5 Oct 1976. Priority date 29 Aug 1974, Canada. 8p.

A description is given of a rotatable drum that has an interior which tapers in a horizontal direction with a first port at the smaller end for receiving particulate tar sands or coal, and an agglomerating liquid, e.g., water, and a second port at the larger end for receiving an organic material separating liquid, e.g., varsol, with which the agglomerating liquid is immiscible. The first port is, for example, larger than the second port so that the separating liquid will drain from the drum through the first port. A conveying means delivers the particulate material and agglomerating liquid into the drum interior, and the separating liquid forms a slurry with it. The inorganic residue from the particulate material is formed into ball agglomerates as it tumbles along the drum, and the ball agglomerates overflow through the second port while the separating liquid fed into the second port separates organic material from the particulate material (tar sands) in the drum and overflows through the first port.

32057 Tar sands conditioning drum. Raymond, B.W.; Riva, D.A.; Stuchberry, F.C. (to Shell Oil Co.). US Patent 3,984,920. 12 Oct 1976. Filed date 3 Apr 1975. 8p.

A rotating drum type muller is described for initial conditioning of mined tar sands by the hot water method for separation of bitumen from the sands. Ablation of mined tar sand lumps into pulp is effected through the addition of hot water, steam, and caustic. This conditioning drum consists of a horizontally disposed cylindrical drum of a length to diameter ratio of about 1:1 or less, rotatable around its longitudinal axis. It has axial openings at its inlet end for introduction of mined tar sand lumps, water, and caustic and at its outlet end for rejection of oversize particles. The axial opening at the outlet end is delimited by a grated peripheral opening for discharge of the tar sand pulp. The grate size is sufficient to allow ready passage of the tar sands pulp while retaining the oversize. A plurality of downwardly projecting steam conduits is affixed to a stationary steam header extending substantially over the length of the drum interior along the longitudinal axis of the drum. The conduits are perforated for injecting steam into the cylindrical drum.

32058 Hot water extraction cell containing two or more deflection baffles. Baillie, R.A.; Davitt, H.J.; Rose, D.E. (to Great Canadian Oil Sands Ltd.). US Patent 3,986,592. 19 Oct 1976. Filed date 4 Nov 1974. 8p.

A description is given of an improved separation cell specifically designed for use in the hot water process for treating tar sands. The separation cell contains a tank with an upwardly concave bottom and a rotatable center shaft running on the vertical axis of the tank from the top to the bottom. Middlings outlets are at the side of the tank, a sands discharge outlet at the bottom of the tank, and an overflow means is connected at the side of the tank. A sand rake is connected to the center shaft to rotate with the shaft and positioned to move settled sand toward the sand discharge outlet. A means for rotating the center shaft is provided. The improvement consists of a combination of two or more saucer-shaped deflecting baffles located in the cell and concentric with the shaft and affixed to it. The lowest baffle is located immediately above the sand rake, inverted to the bottom of the cell, and with a skirt extending downward from the outer periphery of it. At least one other deflecting baffle is located in between the feed well and the lower baffle.

32059 Method of separating bitumen from tar sand with cold solvent. Park, J.H.; Allen, J.C. (to Texaco Inc.). US Patent 3,993,555. 23 Nov 1976. Filed date 16 May 1975. 6p.

A method is described for separating bitumen from tar sand by solvent extraction with efficient separation of water from the recovered bitumen. Tar sand may often be recovered by surface mining techniques. The tar sand is contacted with bitumen solvent having a freezing point below that of the water, and the temperature of the mixture is lowered below the freezing point of the water in the tar sand. The solid ice crystals may then be easily removed along with the sand leaving a water-free liquid bitumen solvent mixture. 20 claims, 2 figures.

32060 Hydrocracking process for the production of synthetic fuels. Gifford, P.H. II. US Patent 4,001,105. 4 Jan 1977. Filed date 11 Oct 1974. 18p.

This invention is a process for the continuous and simultaneous retorting and hydrocracking of the carbonaceous materials found in such carbon containing solids as oil shale, coal, tar sands, lignite, and/or other carbon containing solids, and/or heavy liquids to produce low boiling liquid hydro-carbons and/or a gaseous product suitable for the subsequent production of methane or synthetic natural gas. It is a process by which high to very high molecular weight carbonaceous materials can be effectively and economically converted at high yields to either a low boiling crude of from 30° to 60° API gravity or a gas suitable for the subsequent production of methane, or both. The process consists of creating a catalytically reactive mass, whose active component is activated spent shale, in a reaction zone to which is fed oil shale or a mixture of oil shale and other carbonaceous feeds to be liquified-gasified, and the liquifying-gasifying agents, steam and oxygen; and from which is obtained a low boiling liquid hydrocarbon and gas, and spent shale and ash which are essentially free of any carbonaceous residue. The temperature at which the reaction zone is operated determines to a great extent the relative distribution of the products between liquids and gases. The higher the temperature the greater will be the percentage of the feed which is gasified. 26 claims.

WASTE RESEARCH AND MANAGEMENT

32061 Method of storing sludge recovered from the hot water extraction of bitumen from tar sands. Ashton, J.E.; Davitt, H.J. (to Great Canadian Oil Sands Ltd.). US Patent 3,951,800. 20 Apr 1976. Filed date 11 Sep 1974. 8p.

An environmentally attractive method is described for storing sludge containing water, mineral matter, bitumen, and liquid hydrocarbon formed in a retention pond used to store effluent discharge waste streams associated with aqueous extraction of bitumen from tar sands comprising inserting the sludge below the surface of an unpolluted pond. 1 claim, 1 figure.

32062 Method of reducing sludge accumulation from tar sands hot water process. Baillie, R.A.; Fear, J.V.D. (to Great Canadian Oil Sands Ltd.). US Patent 3,953,318. 27 Apr 1976. Filed date 17 Oct 1974. 6p.

A method is described for reducing the sludge layer in an effluent retention pond associated with hot water extraction of bitumen from tar sands comprising recycling sludge from the retention pond to aid in removing the aqueous effluent discharge from the extraction process and thereby effect a reduction of the volume of the sludge layer in the pond. 2 claims, 1 figure.

FISSION FUELS

32063 For establishment of nuclear fuel cycle. Matsui, A. (Atomic Energy Commission. Tokyo (Japan)). *Genshiryoku Kogyo;* 22: No. 1, 65-71(Jan 1976). (In Japanese).

For establishment of nuclear fuel cycle major problems of nuclear fuel cycle are generally reviewed. As the introduction, the increasing needs for nuclear energy and uranium resources are discussed together with the estimated amount of natural uranium

resources in the world. The second part discusses the Japanese policy for acquiring uranium resources, which relies mainly on joint ventures with other countries. The third part reviews the need and supply of enrichment capacity. The Japanese plan for constructing a centrifuge pilot plant is also briefly discussed. The estimated increasing capacity for enrichment in major countries up to 1985 is shown. Another table shows the estimated increase of Japanese demands for nuclear power, U_3O_8, SWU, and reprocessing capacity. The fourth part discusses the reprocessing capacity referring to existing foreign plants and the newly built Japanese 210 ton/year plant. The fifth part briefly reviews present rends of plutonium thermal utilization. The final part of this report discusses the problems of final disposal of radioactive wastes.

32064 Some problems on use of nuclear fuels and optimum design. Matsumoto, C. (Shikoku Electric Power Co. Inc., Takamatsu (Japan)). *Genshiryoku Kogyo;* **22**: No. 3, 65-69(Mar 1976). (In Japanese).

Problems on planning the long-range use of nuclear fuel are discussed. The long term forecast of fuel cycle and operational plan including the utilization rate of power plants must be taken into consideration. The utilization of recovered uranium and plutonium is forecast to be effected by 1980. Exchange of fuels depends on the coefficient of utilization (the maximum limit within 75 - 80%) and cycle burn-up, and problems are discussed to make the fuel exchange time most suitable. It is necessary to prepare spare fuel.

RESERVES

REFER ALSO TO CITATION(S) 32744

32065 Nabarlek uranium deposit. Anthony, P.J. pp 304-308 of In Economic geology of Australia and Papua New Guinea. I. Metals. Knight, C.L. (ed.). Parkville, Australia; Australas. Inst. Min. Metall. (1975).

The geology, ore body and mineralization of the Nabarlek deposits are described.

32066 Gamma-ray spectrometer measurement of $^{238}U/^{235}U$ in uranium ore from a natural reactor at Oklo, Gabon. Moxham, R.M. *J. Res. U.S. Geol. Surv.;* **4**: No. 5, 589-592(1976).

A sample from the Oklo deposit containing about 0.51 atom percent ^{235}U (by mass spectrometer) was analyzed by a gamma-ray spectrometer system, using a high-purity planar germanium detector. The ^{238}U was determined from its daughter's (^{234}Th) 63.3 keV photopeak; the ^{235}U was determined from its 143.8 and 163.4 keV photopeaks. The ratios of these photopeaks were compared with that from a standard having normal uranium isotopic content; the resulting calculations give a ^{235}U abundance of 0.54 atom percent in the Oklo sample. The gamma-ray spectrum also contains lines from five other isotopes in the uranium series, which indicate the Oklo sample to be at or near secular equilibrium, as the time elapsed since the nuclear reaction ended was sufficient to permit the daughters to achieve equilibrium.

32067 Sedimentary depositional environments of uranium and petroleum host rocks of the Jackson Group, south Texas. Dickinson, K.A. *J. Res. U.S. Geol. Surv.;* **4**: No. 5, 615-629(1976).

Determination of depositional environments in rocks of the Jackson Group of late Eocene age aids in the exploration for uranium and petroleum in south Texas. During deposition of the Jackson Group, conditions were similar to those existing along the modern Gulf Coast of Texas except for a less arid climate and a greater supply of volcanic sediment. Sedimentary depositional environments recognized in both the modern coast and the Jackson rocks, in order from sea toward land, are: shoreface, beach, lagoon and bay, and paludal. Sediment deposited in these environments in places is interbedded with or transected by fluvial sediment. Both uranium and petroleum are found in the shoreface, beach, and fluvial facies. These facies are characterized by permeable well-sorted sandstone, which is commonly overlain and underlain by less permeable mudstone. Recognition of the various facies in outcrops and drill holes is necessary for determination of true stratigraphic relations and for aid in exploration for beach and fluvial sandstone favorable for uranium and petroleum accumulations.

EXPLORATION

REFER ALSO TO CITATION(S) 31803

32068 (DExM-B—1) Summary of prospecting for radioactive minerals in Brazil 1952/1960. White, M.G.; Pierson, C. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Diretoria Executiva da Area Mineral). 1974. 24p. (In Portuguese). NTIS (US Sales Only).

Descriptions of the geologic setting of localities where anomalous radioactivity was detected are presented. The four principal areas where possibly significant uranium deposits were discovered are: the sedimentary rocks of the Tucano Basin in the east-central portion of the State of Bahia; the zirconium ores in the alkaline rocks of Pocos de Caldas Plateau in the State of Minas Gerais; the gold-bearing conglomerates of the Serra de Jacobina in the central part of the state of Bahia and in the coal of southern Brazil, particularly in the Cambui-Figueira area of the Rio do Peixe coal field in northern Parana State. The two principal localities where thorium and associated rare earths were discovered are Morro do Ferro in the Pocos de Caldas Plateau and near the junction of the Ribeira and Itapirapua Rivers on the Sao Paulo-Parana border.

32069 (DExM-B—6) Uranium and gold in Serra da Jacobina. Lemos, J.C. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Diretoria Executiva da Area Mineral). 1974. 24p. (In Portuguese). NTIS (US Sales Only).

The study in details of the conglomerates of Serra do Corrego Formation is presented. In the Canavieira Gold Mine we made the radiometric research of the work front, systematic sampling and gamma-ray of drilled holes. Many ore products from the jig of Canavieira Mine were analyzed to determine a representative uranium content.

32070 (INIS-mf—3220) Annual report 1975. (Eldorado Nuclear Ltd., Ottawa, Ontario (Canada)). 15 Mar 1976. 15p. TIC.

Eldorado is involved in a vigorous uranium exploration program in Canada, reflecting, as do sales and profits for 1975, the extraordinary turnaround in the uranium market. The Beaverlodge mining operation is being expanded. Increased public awareness of the nuclear industry has called for increased research and communications in waste management and associated environmental protection.

32071 (LA—6708-PR) Hydrogeochemical and stream sediment reconnaissance of the National Uranium Resource Evaluation Program. Progress report, October—December 1976. Aamodt, P.L.; Hansel, J.M. Jr.; Minor, M.M.; Beckman, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 31p. Dep. NTIS $4.50.

Field sampling in New Mexico was limited this quarter to the collection of water and/or sediment samples from 4000 locations in two 20,000-km^2 areas in the southeastern corner of the state. Approximately 1100 locations were sampled in Montana and Colorado as parts of pilot studies in those states, and 100 locations were sampled by a commercial contractor in south-central Wyoming. Several thousand samples were inventoried and sent to the analytical laboratories for analysis. A major effort has gone into the preparation of reports for open filing next quarter. These include reports on pilot and orientation studies, reconnaissance sampling, and topical subjects. Uranium analysis of waters by fluorometry continued at an average rate of 850 analyses per week throughout the quarter. Multielement analysis capability using x-ray fluorescence and spectrochemical methods continued to be improved to increase both sample throughput and analytical precision. Modifications to the reactor transport system have lowered the effective uranium detection limit for 40-ml water samples to 0.25 ppb. The pneumatic transfer system has also been expanded to allow rapid multielement analyses of sediment samples. Not all of the detectors have been installed to complete this system, but they will be in the next few months. Sediment samples have been analyzed for uranium at an average rate of 1000 per week during this quarter. Several new computer programs have been developed to improve both the management and statistical treatment of NURE-HSSR data.

32072 (PAEC(D)—75002) Exploration for uranium and other nuclear materials. A guide applicable to the Philippines. Hernandez, E.C. (Philippine Atomic Energy Commission, Diliman, Quezon City). May 1975. 45p. NTIS (US Sales Only).

Prospecting and exploration for uranium and other nuclear minerals have one advantage over prospecting for other metals because of their inherent radioactivity. Radioactivity in the earth is not confined solely to these elements but also to radiations coming from cosmic rays and from fallouts from large-scale atomic and nuclear explosions. The primary uranium mineral is uraninite, however, concentrations of other uranium minerals may also lead to an economic deposit. Thorium is about three times more abundant than uranium in the earth's crust. Uranium is practically found in many types of geologic environment it being ubiquitous and very mobile. Uranium deposits are classified in a descriptive manner, owing to lack of basic information as to its origin. These classifications are peneconcordant, for deposits as conglomerates and sandstones, discordant for vein pegmatite and contact metamorphic deposits, concordant for deposits in shales and phosphate rocks, and miscellaneous for deposits in beach and placer sands containing mostly thorium minerals. The different exploration techniques and their associated instrumentations are discussed from a regional scale

survey to a detailed survey. To date, only the Larap copper-molybdenum-magnetite deposit at the Paracale district, Camarines Norte in the Philippines, has been found to contain uranium as discrete uraninite grains in the ore mineral assemblage of the deposit.

MINING

REFER ALSO TO CITATION(S) 31771, 32138

32073 (PB—256394) **Metals mining and milling process profiles with environmental aspects. Final report Aug 75-May 76.** Nerkervis, R.J.; Hallowell, J.B. (Battelle Columbus Labs., Ohio (USA)). Jun 1976. Contract EPA-ROAP-21AFH—025. 318p. NTIS (US Sales Only) $9.75.

The report describes the environmental aspects of metals mining and milling (concentration) operations in the U.S. The metals include Al, Sb, Be, Cu, Au, Fe, Pb, Zn, Hg, Mo, Ni, Pt, the rare earth metals, Ag, Ti, W, U, and V. The types of environmental impacts associated with operations from mining through production of concentrate are described in general terms. The number and locations of plants, the names of producing companies, production levels, and other characteristics of the industry is presented. Each unit process is described in terms of function, input materials, operating conditions, utilities and energy use, and waste streams. The descriptions of unit processes identify waste streams in terms of emissions to the air, water effluents, and solid wastes disposed to the land. The approximately 185 unit operations described include mining, dredging, crushing, flotation, leaching, sintering, and nodulizing. The most common waste streams are dusts from mining and crushing operations, liquid streams from mine drainage, flotation operations, tailings ponds, and leaching operations. (GRA)

FEED PROCESSING

REFER ALSO TO CITATION(S) 32142

32074 (LBL—5792) **Molecular beam study of the kinetics of the fluorine—uranium dioxide reaction.** Machiels, A.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1976. Contract W-7405-ENG-48. 128p. Dep. NTIS $6.00.

Thesis.

The kinetics of uranium dioxide fluorination were studied using an experimental system in which a molecular beam of fluorine was directed at a heated uranium dioxide single crystal wafer maintained in high vacuum. Gaseous reaction products desorbed from the uranium dioxide were monitored by a quadrupole mass spectrometer with an off-axis electron multiplier. The fluorine beam was modulated; ac phase-lock detection and pulse counting were employed to enhance the signal-to-noise ratio. The uranium dioxide targets were heated from the rear by electron bombardment to a maximum of 1800°K. Fluorination of the uranium dioxide was found to produce uranium tetrafluoride in the 900° to 1600°K temperature range, confirming the results obtained from thermodynamic considerations (quasi-equilibrium analysis). Fluorination of the uranium dioxide was found to be affected by some process acting as a flywheel smoothing the phase response of the interaction as the modulation frequency was varied.

32075 (PNCT—842-75-05) **Recovery of uranium from wet-process phosphoric acid.** Hirono, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). May 1975. 78p. (In Japanese). NTIS (US Sales Only).

It is inferred that the total amount of uranium in phosphoric fertilizer produced in all the countries of the world will be over 12000 tons per year. This amount is equivalent to 30 to 40 per cent of the uranium consumption of the world in 1975, representing a significant potential source of uranium, although the amount of uranium has been unusefully scattered over the ground. In this report, the processes for recovery of uranium in 1950 to 1960 and the recent time in USA have been described in detail, quoting from ten-odd papers. The recent processes for recovery of uranium are liquid-liquid solvent extractions, consisting of OPPA or the combination of D2EHPA and TOPO, having high distribution coefficient and stability. The recent processes have a high probability to be commercialized, because the total chemical reagent costs for the processes, based on the continuous bench-scale tests, are estimated to be less than $1/lb of U_3O_8. However, because the scales of commercial plants in Japan are generally smaller than in USA, the researches for the processes and equipments for the recovery of uranium fitting to the plants in Japan will be necessary.

32076 **Processes for recovering uranium values from ores.** Smith, S.E.; Le page, R.; Garvett, K.H. (to UKAEA). Australian Patent 470,017/B/. 12 Feb 1976. 23p.

Filed 15 Apr 1971, publ. 19 Oct 1972, priority UK 21 May 1970 (70/24769), copies available from the Commissioner of Patents, Canberra.

A process is described for recovering uranium values from an ore which contains uranium as a finely disseminated refractory mineral or minerals comprising the steps of: (a) comminuting the ore to a top size not substantially smaller than 1mm; (b) mixing the comminuted ore with sulphuric acid of normality greater than 4N in sufficient quantity to wet the ore without forming a continuous phase; (c) allowing the mixture to cure for a period at a temperature not substantially exceeding 100°C; (d) prior to the curing providing sufficient heat so that the mixture will be at a temperature not substantially exceeding 100°C during the curing; and (e) contacting the cured mixture with a liquid to elute the uranium.

32077 **Solvent extraction of uranium from dilute solutions using a gas-bubble mixed extraction column.** Andreini, R.J.; Lower, G.W.; DeMull, T.J. Jr. *Metall. Trans., B;* 7: No. 2, 253-258(Jun 1976).

A modified solvent extraction process for recovering U from very dilute solutions, such as mine waters or Cu dump liquors, was developed and tested on a laboratory scale. The system utilizes a column in which the aqueous feed flows downward through a liquid organic extractant. A countercurrent flow of gas is used to achieve mixing and enhance mass transfer. Acid sulphate solutions at pH 1.5 containing either 0.010 or 0.015 g/l U_3O_8 comprised the feed. The extractant used was Alamine 336 dissolved in fuel oil. Critical parameters of the system, such as length to dia ratio of the organic phase, volume ratio of aqueous to organic in the column and flow rates of aqueous feed and gas are examined.

32078 **Sulfide precipitation method of separating uranium from Group II and Group III metal ions.** Sundar, P.S. (to Westinghouse Electric Corp.). US Patent 4,002,716. 11 Jan 1977. Filed date 23 Aug 1973. 8p.

Uranium is separated from analytical Group II and Group III metal ions in an aqueous liquor containing uranyl ions. The liquor is extracted with a non-interfering, water-immiscible, organic solvent containing a reagent which will react with the uranyl ions to form a complex soluble in the solvent. If the liquor is acidic, the solvent is washed with water. Then to the solvent is added an aqueous solution containing about 0.5 to 1.0 mole per liter of $(NH_4)_2CO_3$ or NH_4HCO_3 ions and sufficient sulfide ions to precipitate the metal ions as sulfides. The solvent and the aqueous solution are separated and the sulfides filtered from the aqueous solution. The ammonium-uranyl-tricarbonate in the aqueous solution can then be precipitated by increasing the concentration of $(NH_4)_2CO_3$ or NH_4HCO_3 ions to about 1.5 to 2.5 moles per liter. The precipitate is filtered and calcined to obtain U_3O_8 or UO_2. 21 claims, 1 figure.

32079 **Process for producing uranium rich compositions from uranium hexafluoride using fluid injection in the post oxidation step.** Dada, A.G. (to General Electric Co.). US Patent 4,005,042. 25 Jan 1977. Filed date 2 Jul 1975. 10p.

An improved process for the conversion of gaseous uranium hexafluoride to a uranium oxide rich composition in the presence of an active flame in a reaction zone is disclosed and comprises introducing a first gaseous reactant comprising a mixture of uranium hexafluoride and an oxygen-containing carrier gas and a second gaseous reactant comprising a reducing gas, the reactants being separated by a shielding gas as introduced to the reaction zone. The shielding gas temporarily separates the gaseous reactants and temporarily prevents substantial mixing and reacting of the gaseous reactants. The flame occurring in the reaction zone is maintained away from contact with the inlet introducing the mixture to the reaction zone. The process also includes introducing an oxygen-containing gas as a third gaseous reactant at a time when the uranium hexafluoride conversion to uranium oxide is substantially complete resulting in oxidizing the uranium oxide composition to a higher oxide of uranium and conversion of the residual reducing gas to its oxidized form. During the process there is practiced the improvement of introducing an atomized fluid having a high latent heat of evaporation so that the atomized fluid is enveloped or surrounded by the third gaseous reactant as it is introduced into the reaction zone, and the atomized fluid enters the reaction zone without contacting the structure defining the reaction zone and at a location at about the maximum temperature of the reaction zone. 14 claims, 4 drawing figures.

ENRICHMENT

32080 (AED-Conf—76-481-002) **Basic phenomena of flows and diffusion processes in the separation nozzle.** Ehrfeld, U.; Ehrfeld, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Kernverfahrenstechnik). 1976. 4p. (CONF-7609112—4). NTIS (US Sales Only).

From Euromech-colloquium-80 on separation phenomena in gas mixture flows; Karlsruhe, German, Federal Republic of (F.R. Germany) (6 Sep 1976).

4 figs.; 10 refs. Short communication only.

32081 (AED-Conf—76-481-003) **Test facilities and procedures for optimizing separation nozzle systems.** Bley, P.; Ehrfeld, W.; Knapp, U. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Kernverfahrenstechnik). 1976. 2p. (CONF-7609112—1). NTIS (US Sales Only).

From Euromech-colloquium-80 on separation phenomena in gas mixture flows; Karlsruhe, German, Federal Republic of (F.R. Germany) (6 Sep 1976).

2 figs.; 10 refs. Short communication only.

32082 (AED-Conf—76-481-004) **Theoretical analysis of ternary diffusion phenomena in the separation nozzle.** Berkhahn, W.; Ehrfeld, W.; Krieg, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Kernverfahrenstechnik). 1976. 2p. (CONF-7609112—2). NTIS (US Sales Only).

From Euromech-colloquium-80 on separation phenomena in gas mixture flows; Karlsruhe, German, Federal Republic of (F.R. Germany) (6 Sep 1976).

1 fig.; 4 refs. Short communication only.

32083 **Uranium enrichment in South Africa.** Roux, A.J.A.; Grant, W.L. (Uranium Enrichment Corp. of South Africa, Ltd., Pretoria). pp 39-43 of In Nuclear energy maturity. Zaleski, P. (Electricite de France, 75 - Paris); Sher, R.; Mantega, M.; Gueron, J.; Williams, M.M.R. (eds.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

It is stated that the South African process is of an aerodynamic type, the separating element being in effect a high performance stationary-walled centrifuge using UF_6 in hydrogen as process fluid. Some details of the very low uranium inventory and high separation factor achievable are given. A new cascade technique is described, based on the principle that an axial flow compressor can simultaneously transmit several streams of different isotopic composition without there being significant mixing between them. The research and development program is discussed. It is expected that an enrichment plant of 5000 t/a SW capacity, with provision for expansion up to 10,000 t/a SW capacity, will come into operation by 1984.

32084 **Opening of the industrial period of enrichment.** Taranger, P. (CEA Direction des Productions, 92 - Chatillon (France)). pp 83-84 of In Nuclear energy maturity. Zaleski, P. (Electricite de France, 75 - Paris); Sher, R.; Mantega, M.; Gueron, J.; Williams, M.M.R. (eds.). Oxford; Pergamon (1976). (In French)

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The annual value of the world's needs for separative work is quoted to show that uranium enrichment is an industrial reality. Enrichment organizations in which France is concerned are discussed, in particular Eurodif. The financial basis and industrial structure of this multinational body are explained. The importance, to the gaseous diffusion uranium enrichment industry, of raw materials and power is stressed, and the need to consider how the industry fits into the fuel cycle and how it should be related to the production of natural uranium. The policy on commercial activities and contracts with customers is discussed. Plans to construct a second commercial plant under an organization Coredif (participants: Eurodif, C.E.A. and the Atomic Energy Authority of Iran) are described.

32085 **Comments on the new methods and process developments discussed at the international conference on uranium isotope separation, London, March 1975.** Williams, J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 1-4 of In Nuclear energy maturity. Zaleski, P. (Electricite de France, 75 - Paris); Sher, R.; Mantega, M.; Gueron, J.; Williams, M.M.R. (eds.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

A review is presented of papers presented at the B.N.E.S. Conference at the two sessions dealing with New Processes and Developments. The comments are grouped as follows: laser-induced processes, rotating plasmas, ion exchange, and aerodynamic methods (the main contribution being on the nozzle process). It is stated that on the basis of the evidence presented at the London meeting the following general impressions remained: (a) the only 'new' process likely to be proved on an industrial scale within the next 5 to 10 years was a nozzle process. This also appeared to have development potential, as yet not fully exploited. (b) Chemical exchange processes were highly economical and it remains for discussion whether thermodynamically reversible processes with low stage separation factors and relatively long equilibration times can now be ruled out from further consideration. (c) Theoretical understanding of the dynamics of gas flow in situations pertinent to isotope separation seemed either inadequate or very difficult to apply. This situation was further aggravated when the working fluid was partially or fully ionized. (d) With respect to the use of laser-separation techniques only the scientific and technical difficulties were discussed, with little reference to successes that were likely to yield anything of economic significance.

GASEOUS DIFFUSION

32086 (JAERI-M—6272) **Studies on dynamic behavior of gaseous diffusion plant (1).** Naruse, Y.; Maruyama, Y.; Aochi, T.; Higashi, K.; Yamazaki, H. (Japan Atomic Energy Research Inst., Tokyo). Oct 1975. 58p. (In Japanese). NTIS (US Sales Only).

A gaseous diffusion plant is a large-scale, multi-stage separation system composed of about a thousand stages in cascade to obtain the slightly enriched uranium for LWR. In order to design, construct and operate the plant, it is necessary to know static and dynamic behaviors of the system. Dynamic equations for the square cascade are derived and the 8750 ton-SWU/yr plant is analyzed. Transient behaviors are treated for the start-up and the removal/addition of any blocks of the cascade at steady state.

CENTRIFUGATION

32087 **Commercial aspects of the gas centrifuge method.** Mohrhauer, H. (Geschaftsfuehrung Uranit, Julich (F.R. Germany)). pp 77-78 of In Nuclear energy maturity. Zaleski, P. (Electricite de France, 75 - Paris); Sher, R.; Mantega, M.; Gueron, J.; Williams, M.M.R. (eds.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The present status and aims of the URENC/CENTEC organization are summarized: the activities of each of the three collaborating parties in the United Kingdom, The German Federal Republic and the Netherlands are stated. The safety, reliability and ease of operation of the centrifuge plants are said to have been demonstrated by pilot plant experience. The economics of the process are discussed, as well as commitments, plans and forecasts for full scale production. It is emphasized that as expansion of centrifuge enrichment plants and the necessary machine facilities can be brought into full production within a period of 4 to 5 years it is not necessary to invest heavily in new plant until the electric power utilities have made their decision to build reactors.

32088 **Rotating concentric homogeneous turbulence centrifuge.** Leith, W.C. (to Cominco Ltd.). US Patent 3,998,610. 21 Dec 1976. Filed date 12 Dec 1974. 8p.

A gas centrifuge and a method are described for the separation of isotopic gaseous mixtures, particularly for the enrichment of uranium by the evaporative, concurrent-flow and countercurrent-flow principles using Taylor circular Couette motion. Gaseous isotopes either alone or mixed with a carrier gas, more particularly uranium isotopes in mixture with uranium hexafluoride carrier gas, are fed to a rotor assembly of a gas centrifuge which comprises two concentric cylinders which may be rotated at the same or at different angular velocities and in the same or opposite directions to create centrifugal forces sufficient to diffuse the heavier fraction of the gas mixture to the periphery of the assembly and the lighter fraction towards the axial portion of the assembly. The rotor comprises an inner, perforate, rotatable cylinder and an outer, continuous, smooth-walled, rotatable cylinder concentric with the inner cylinder and defining an annulus therebetween. 14 claims, 5 figures.

LASER EXCITATION

32089 **Enrichment by photoexcitation.** Tait, J.H. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 33-36 of In Nuclear energy maturity. Zaleski, P. (Electricite de France, 75 - Paris); Sher, R.; Mantega, M.; Gueron, J.; Williams, M.M.R. (eds.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

This paper reviews published information on the possible use of lasers in uranium isotope separation. Summaries are given of the present state of relevant laser technology and on known spectroscopic data of uranium and uranium compounds.

32090 **Application of high power lasers to problems in the nuclear fuel cycle.** Birely, J.H.; Cartwright, D.C.; Marinuzzi, J.G. (Los Alamos Scientific Lab., NM). pp 124-131 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

Recent experimental LIS results obtained using the methods of single- and multiple-photon dissociation and laser-induced chemical reaction employing a single laser are reviewed. Also discussed are recent experiments on several- and multiple-photon methods that employed more than one laser wavelength. For each of these processes, methods are given for estimating the minimum laser require-

ments. Also discussed are the projected ir and uv laser requirements to proceed from scientific proof-of-principle, through medium-size scaling experiments, to the full-sized uranium enrichment plant for a two-step photodissociation process currently under investigation in this laboratory.

32091 Measurement of atomic uranium lifetimes for isotope separation. Klose, J.Z. (National Bureau of Standards, Washington, DC). pp 150-155 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

Following a brief discussion of uranium isotope separation using lasers, the delayed coincidence method of measuring atomic mean lives with pulsed electron beams utilized here is described along with the beam source used to supply the free uranium atoms for measurement. Experimental details involved in the lifetime measurement are next discussed followed by the effect of resonance radiation imprisonment on the measured lifetimes. finally, lifetime measurements involving the 3584.9 A and 5915.4 A transitions in natural uranium are described, and the previously reported result of 7.3 +- 1.1 ns for the mean life of the upper level of the 3584.9 A transition (27886.99 cm^{-1}) is presented.

32092 Floating convection barrier for evaporation source. Janes, G.S. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 3,996,469. 7 Dec 1976. Filed date 6 Jan 1975. 6p.

This patent describes a floating mass or matrix for use in the melt of an electron beam vapor source to permit a wide latitude of evaporant level without necessary replenishment while at the same time reducing convective currents in the melt. This vapor source is applicable to uranium vapors used in laser enrichments. (DLC)

32093 Laser alteration of accommodation coefficient for isotope separation. Keck, J.C. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 3,996,470. 7 Dec 1976. Filed date 15 Oct 1974. 10p.

This patent describes a method and an apparatus for separating isotope types by inducing an isotopically selective vibrational excitation of molecules containing at least one atom of the element type whose isotopes are to be separated. Vibrational excitation is induced in the molecules by finely tuned, narrow bandwidth laser radiation applied to a gaseous flow of the molecules. Isotopic separation of the molecules is achieved from the enhanced difference in diffusion rates for the molecules due to an alteration of the accommodation coefficients in the excited molecules. 40 claims, 4 figures.

32094 Laser isotope separation process. Kaldor, A. US Patent 4,000,051. 28 Dec 1976. Filed date 23 Apr 1975. 6p.

The claimed invention is a method of isotope separation based on the unimolecular decomposition of vibrationally excited negative ions which are produced in the reaction of thermal electrons and molecules which have been vibrationally excited in an isotope selective manner. This method is especially applicable to molecules represented by the formula MF_6 wherein M is selected from the group consisting of U, S, W, Se, Te, Mo, Re, and Tc. 9 claims, 1 drawing figure.

32095 Wire anode for isotope separation apparatus. Janes, G.S.; Dotson, J.P. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 4,000,421. 28 Dec 1976. Filed date 30 Sep 1974. 8p.

In uranium enrichment, an electrode structure of thin, tensioned, parallel wires is claimed for use in applying an electric field to a region of a flowing uranium plasma including selectively ionized particles in order to accelerate the ionized particles for separate collection without interfering with the motion of neutral particles. 24 claims, 3 drawing figures.

32096 Method and apparatus for separating isotopes. Harris, S.E. (to Board of Trustees of Leland Stanford Junior Univ.). US Patent 4,000,420. 28 Dec 1976. Filed date 11 Jun 1974. 12p.

Isotope separation is achieved between species A and B having an absorption resonance separated by an isotopic shift by selectively exciting a portion of species A using a tunable photon source of narrow emission line with and subsequently causing collisions with an optically excited third species to selectively ionize the excited portion of species A. When ionized, species A is easily separated by any technique, using its ionized condition to distinguish it from species B. 18 claims, 3 drawing figures.

32097 Isotope separation process. Lyon, R.K. (to Exxon Research and Engineering Co.). US Patent 4,003,809. 18 Jan 1977. Filed date 23 Apr 1975. 10p.

The instant invention relates to a process for separating a material into two or more parts in each of which the abundances of the isotopes of a given element differ from the abundances of the isotopes of the same material in said material. More particularly, the invention relates to a method for the isotopically selective excitation of gas phase molecules by multiple infrared photon absorption followed by a step wherein more of the excited molecules than nonexcited molecules are converted to a chemically different form which may be separated by means known in the art. This invention is useful for, but not limited to, the separation of the principal isotopes of uranium. 15 claims, 1 figure.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 32105, 32108, 32139, 32352, 32529, 32535, 32803, 32848, 33092

32098 (HEDL-TME—76-75) Radiation exposure control technology semiannual progress report, June—December 1975. Smith, R.C.; Strode, J.N.; Brackenbush, L.W.; Faust, L.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-2170. 22p. AT.

This is the third semiannual program report on the program being conducted to measure and control radiation levels during Pu fuel fabrication. Measurements of the neutron attenuation for several high-efficiency neutron shielding materials under slightly differing neutron scattering conditions are given. Results of a three-month radiation exposure measurement program conducted at the Nuclear Materials Division of Babcock and Wilcox during production of fuel for FFTF are also included. (DLC)

32099 (Juel—1317) Deposition of pyrocarbon of C_2H_2-C_3H_6-Ar-gas mixtures. Coating at inner heat equilibrium. Gyarmati, E.; Gupta, A.K.; Puetter, B. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jul 1976. 38p. (In German). INIS.

13 figs.; 1 tab.; 10 refs.

This study describes the deposition of pyrocarbon in a 55 mm-diameter fluidized bed reactor without heatexchange from a mixture of ethyne propene and argon gas based on thermodynamical calculations.

32100 Calcination system to reduce uranium compounds to UO_2 powder. Cole, E.A.; Peterson, R.S.; Drawer, R. (to Westinghouse Electric Corp.). German(FRG) Patent 2,459,290/A/. 17 Jul 1975. 23p. (In German).

3 figs.

Calcination systems to reduce uranium compounds by heating have to be designed in such a way that no oxygen gets into contact with the hot UO_2. Up to now, large quantities of H_2 were necessary to prevent this. The present invention describes a control system reducing H_2 consumption appreciably. To the circulation furnace heated to about 1,000°C, a filling and cooling device is connected via an air-tight seal, this device having the shape of a long body whose hot and dense UO_2 filling is moved on and circulated by means of a worm conveyor, the filling being cooled down to about 100°C. Inlet as well as outlet for this device are controlled so that any O_2 access can be prevented.

32101 Method to measure gas pressure. Wonn, J.W. (to Westinghouse Electric Corp.). German(FRG) Patent 2,602,368/A/. 5 Aug 1976. 13p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

A method to measure the gas pressure in hermetically sealed casings, e.g. nuclear fuel elements, is described. An acoustic signal is sent through the gaseous medium and, after having passed through a defined propagation distance, is received again and converted into an electric signal which, after suitable calibration, is a direct measure of the gas pressure in the casing.

32102 Mobility of intragranular bubbles in uranium dioxide during irradiation. Turnbull, J.A. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Nucl. Mater.;* **62**: No. 2-3, 325-328(Nov 1976).

A survey of the literature will show that opinion is still divided as to the role of bubble mobility in the kinetics of fission gas release. It must be conceded that the columnar grain structure observed at high temperature and high rating results from the migration of pores up the temperature gradient and as such must be the significant if not dominant gas release process. However, in the cooler regions where equiaxed-grains are found, although there is plenty of evidence of both inter- and intragranular gas bubbles, there is no indication whether or not they are mobile. If a bubble has a diffusion coefficient D/sub b, then even in the absence of a driving force it will change its position, moving a distance (x^2(mean)/sup 1/ 2/ (the root mean square migration distance) in a time t, where in three dimensions (x^2(mean)=6D/sub b/t, and in the two dimensions of a projection on a plane (x^2(mean)=4D/sub b/t. It is therefore argued by some that this random motion and subsequent collision and agglomeration is a major contribution in controlling the intragranular bubble population and hence the escape of fission gas from solution.

32103 **Uranium dioxide preparation.** Watt, G.W.; Baugh, D.W. Jr. (to Exxon Nuclear Co., Inc.). US Patent 4,003,980. 18 Jan 1977. Filed date 21 May 1975. 8p.

An actinide dioxide, e.g., uranium dioxide, is prepared by reacting an actinide nitrate or hydrate or tetrahydrofuranate thereof, e.g., uranyl nitrate, a hydrate of uranyl nitrate, or a tetrahydrofuranate of uranyl nitrate with an alkali or alkaline earth metal adduct of a monocyclic or polycyclic hydrocarbon in the presence of an inert organic solvent. Typically, the starting material may be uranyl nitrate dihydrate or uranyl nitrate ditetrahydrofuranate (the latter material is a novel composition of matter) with a reactant such as the sodium adduct of naphthalene in the presence of a solvent such as tetrahydrofuran. The resultant uranium dioxide may be further purified by heating it in the presence of hydrogen. 15 claims.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 32125, 32721

32104 (AECL—5310, pp 15-17) **Dry storage of spent fuel.** Mayman, S.A. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Feb 1976.

In AECL research and development in engineering, winter 1975.

Storage of irradiated CANDU fuel in water filled bays is a standard, proven procedure. It has been suggested, however, that dry storage methods might show some advantages in the long term. In particular, a dry storage facility is likely to require less maintenance and produce less secondary waste than a wet storage facility of similar capacity. WNRE has undertaken the development of one dry storage concept - the concrete canister - to assess its feasibility and evaluate its cost.

32105 (BNWL—2080-3) **LWR fuel recycle program quarterly progress report, October—December 1976.** Jarrett, J.H. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract E(45-1)-1830. 70p. Dep. NTIS $4.50.

Progress in the following studies is reported: economic and environmental aspects, spent fuel receipt and storage, head end processes, off-gas treatment, Purex process, finishing processes, waste management, and general support. (JRD)

32106 (ERDA—76/121) **Benefit analysis of reprocessing and recycling light water reactor fuel.** (Energy Research and Development Administration, Washington, D.C. (USA)). Dec 1976. 31p. Dep. NTIS $4.00.

The macro-economic impact of reprocessing and recycling fuel for nuclear power reactors is examined, and the impact of reprocessing on the conservation of natural uranium resources is assessed. The LWR fuel recycle is compared with a throwaway cycle, and it is concluded that fuel recycle is favorable on the basis of economics, as well as being highly desirable from the standpoint of utilization of uranium resources. (LK)

32107 (GA-A—14214) **Thorium utilization program. Quarterly progress report for the period ending November 30, 1976.** (General Atomic Co., San Diego, Calif. (USA)). Dec 1976. Contract EY-76-C-03-0167-PRJ-53. vp. Dep. NTIS $9.25.

This publication continues the quarterly series presenting results of work performed under the National HTGR Fuel Recycle Program (also known as the Thorium Utilization Program). Results of work on this program prior to June 1974 were included in a quarterly series on the HTGR Base Program. The work reported includes the development of unit processes and equipment for reprocessing of HTGR fuel, the design and development of an integrated pilot line to demonstrate the head end of HTGR reprocessing using unirradiated fuel materials, and design work in support of Hot Engineering Tests (HET). Work is also described on trade-off studies concerning the required design of facilities and equipment for the large-scale recycle of HTGR fuels in order to guide the development activities for HTGR fuel recycle.

32108 (IAEA—186, pp v.1 p.175-190) **Importance of trans-actinium nuclear data for fuel handling.** Burstall, R.F. (UKAEA, Central Technical Services, Risley). 1976.

From Advisory group meeting on transactinium isotope nuclear data; Karlsruhe, Germany, F.R. (3 Nov 1975).

In Transactinium isotope nuclear data (TND). Proceedings of an advisory group meeting organized by the IAEA Nuclear Data Section in co-operation with the OECD Nuclear Energy Agency held at the Kernforschungszentrum Karlsruhe, 3-7 November 1975.

The paper considers the importance of the actinide group for fuel handling, particularly in comparison with the fission product group. Decay heating and dose rate are considered for thermal and fast reactors. The effects of variants in fuel usage and reactor operation are examined, and it is shown that the storage time of plutonium feed fuel and the origin of this fuel are important features. The implications of the actinide group are examined for a possible FBR transport flask, and it is shown that uncertainties in the actinide group contribution are not likely to greatly affect the design. The implications are also examined for fuel fabrication and reprocessing. Suggestions to re-cycle members of the actinide group in reactors are shown to significantly increase the fuel handling problems. Recommendations are given for desirable improvements in nuclear data.

32109 (Juel—925-CT) **Purification of burner off-gases during reprocessing of irradiated HTR fuel elements.** Grahmann, U.; Tillessen, U.; Beaujean, H.; Filss, P.; Laser, M.; Merz, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). Feb 1973. 98p. (In German). TIC.

23 refs.; with figs. and tab.

Experiments on the reprocessing of irradiated thorium-containing HTR fuel elements by the burn-leach process (the moderator is burned with oxygen) have been performed in the Hot Cells (HZ-2) of the Kernforschungsanlage Juelich. Results of experiments to purify the off-gases from shaft furnaces and fluidized-bed furnaces are summarized below. The condensable and particulate radioactive nuclides like cesium and zirconium released during the burning process were decontaminated by a factor of 10^7 by a series of conventional gas purification steps. Their concentrations in the off-gas were reduced to below the MPC values. The system, porous sintered metal filters in the burner followed by an electrostatic filter in the off-gas treatment plant, was demonstrated as an effective method for the separation of these aerosols. Tritium was removed ($DF < 10^2$) by molecular sieves or silica gel absorber traps. The release rate of Kr-85 was measured continuously during the burning process. Kr- 85 was quantitatively released during the burning of $(U,Th)C_2$ fuels. Only about 7% of the Kr-85 was released during burning of $(U,Th)O_2$ fuels irradiated to 10% ifia. Off-gas concentrations of C-14 and thoron daughter-products were also determined. The design of a large-scale gas purification system for a nuclear fuel reprocessing plant is also discussed.

32110 (LA—6596-MS) **Pyrochemical head-end treatment for spent nuclear fuels.** Bowersox, D.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 8p. Dep. NTIS $3.50.

A program based upon thermodynamic values and scouting experiments at Argonne National Laboratory is proposed for development of a pyrochemical head-end treatment of spent nuclear fuels to replace the proposed chopping and leaching operation in the Purex process. The treatment consists of separation of the cladding from the oxide fuel by dissolution into liquid zinc; oxide reduction of uranium and plutonium and dissolution into a zinc—magnesium alloy; separation of alkali, alkaline earth, and rare earth fission products into a molten salt; and, finally, separation and recovery of the plutonium and uranium in the alloy. Uranium and plutonium would be separated from the fuel cladding and selected fission products in a form readily dissolvable in nitric acid. The head-end process could be developed eventually into an optimum method for recovering uranium, plutonium, and selected fission products and for minimizing wastes as compact, stable solids. Developmental expenses are not known clearly, but the potential advantages of the process are impressive.

32111 (ORNL—5176) **Engineering tests of the metal transfer process for extraction of rare-earth fission products from a molten-salt breeder reactor fuel salt.** Savage, H.C.; Hightower, J.R. Jr. (Oak Ridge National Lab., Tenn. (USA)). Feb 1977. Contract W-7405-ENG-26. 65p. Dep. NTIS $4.50.

In the metal transfer process for removal of rare-earth fission products from the fuel salt of a molten-salt breeder reactor (MSBR), the rare earths are extracted from the molten fuel salt into a molten bismuth solution containing lithium and thorium metal reductants, transferred from the bismuth into molten lithium chloride and, finally, recovered from the lithium chloride by extraction into molten bismuth containing lithium reductant. Engineering experiments using mechanically agitated, nondispersing contactors with salt and bismuth flow rates [approximately 1 percent of those required for processing the fuel salt from a 1000-MW(e) MSBR] have been conducted (1) to study this process, (2) to measure the removal rate of a representative rare-earth fission product (neodymium) from MSBR fuel salt, and (3) to evaluate the mechanically agitated contactor for use in a plant processing fuel salt from a 1000-MW(e) MSBR. The experimental equipment and procedures are described. Results obtained during five experiments in which the rare earth neodymium was extracted from MSBR fuel salt are presented. Removal rates and mass-transfer coefficients between the salt and bismuth phases were determined for neodymium and are discussed in terms of the processing requirements for a 1000-MW(e) MSBR.

32112 (ORNL/TM—5729) **Laboratory development of solvent extraction processes for spent LMFBR fuels.** Horner, D.E.; Crouse, D.J. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 95p. AT.

Results are summarized for laboratory-scale development studies of solvent extraction processes for treating short-cooled LMFBR fuels. Amine extractants were evaluated, but the Purex (TBP extraction) process received principal emphasis and is the recommended process. Extensive plutonium and uranium extraction and stripping data were obtained over a range of nitric acid concentrations, TBP concentrations, and temperatures. These data were used to estimate suitable flowsheet conditions for each process cycle, and batch countercurrent demonstrations were then made with simulated feeds. Finally, 5-cycle batch demonstrations of the first extraction-stripping cycle were made with actual fuel solutions. A computer code (SEPHIS) was developed for predicting the stagewise distribution of plutonium, uranium, and nitric acid in the extraction and stripping systems. Studies of the chemical and radiation stability of TBP in n-dodecane indicated that the effects of solvent degradation should not be very significant even when treating short-cooled LMFBR fuels. Additional process studies included the evaluation of plutonium reductants for use in the partitioning cycle; favorable results were obtained with hydroxylamine nitrate—hydrazine, ferrous nitrate, and uranous nitrate. It was shown that formation of a third liquid phase at high solvent plutonium loadings can be avoided by operating at elevated temperatures (approximately 40°C). Based on the laboratory studies, flowsheet conditions are recommended for a coextraction-partitioning cycle followed by two additional TBP cycles of plutonium purification. The overall conclusion of the studies is that the Purex process can be successfully applied to the processing of short-cooled LMFBR fuels, but this needs confirmation in larger-scale tests.

32113 Method of recovering uranium from uranium-containing fuel elements with a zirconium cladding. Bertlett, C.B.; Wirsing, E. Jr.; Hatch, L.P. (to Energy Research and Development Administration). German(FRG) Patent 1,533,142/C/. 9 Jan 1975. 3p. (In German).

Fluidized-bed process to recover uranium from nuclear fuel elements with a zirconium cladding. In the first process step, the zirconium cladding is removed from the fuel element, and the uranium is then brought to reaction with gaseous fluorine in a subsequent uranium recovery process stp.

32114 (GERHTR—156) Method of separating plutonium from the process streams of a reprocessing plant for HTR fuel elements. Herz, D.; Kankura, R.; Wenzel, U. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). Jul 1975. Translation of JUL—1212. 34p. Dep. NTIS $4.00.

Work performed under United States—German High Temperature Reactor Research Exchange Program.

The process streams of a reprocessing plant for Th-U fuel elements can be purified of Pu, using a chromatographic method. The process is based on the principles of extraction chromatography with the application of the method of breakthrough chromatography. The inert carrier consists of polytrifluoromonochloroethylene, TOA forming the steady-state phase and 2 M HNO_3 the mobile phase. After adjustment of the feed solution to the extraction conditions, Pu is extracted in the separating column to the steady-state phase. The height of the separating stages is expressed by the equation HTS (cm) = 0.2 + 0.65 u_0 (cm min^{-1}). Due to the delayed Pu/Th exchange in TOA, it depends heavily on the linear flow velocity. Details are given of the design of a separating unit for a flowrate of 2 kg of heavy metal per day (the flowrate of the Jupiter plant). (12 fig, 4 tables)

32115 Apparatus to carry out chlorination reactions. Bohnenstingl, J.; Gebhard, H.; Laser, M.; Lossmann, G. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,262,881/C/. 7 Aug 1975. 4p. (In German).

1 fig.

A hardly disturbance-liable chlorination device is suggested allowing large flows so that chlorinations of all kind (production of metals as Ti, Zr or U, Th in the reprocessing of burnt-off fuel elements etc.) are performable in an economical way. The cupola furnace as well as the casing of the cupola furnace and the joining socket connecting the cupola furnace and the condenser consist of graphite, the whole assembly is arranged within a gas-tight envelope of steel. In order that no tensions exist between the components, the joining socket is designed as cantilever beam. The embodiment shows the purification of graphite by chlorination.

32116 Experience in the construction of a spent nuclear fuel reprocessing plant. Yamashita, H. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Karyoku Genshiryoku Hatsuden;* **27**: No. 1, 41-51(Jan 1976). (In Japanese).

The construction and operation of a reprocessing plant was first published in 1956. The Reprocessing Expert Committee of AEC was established in 1959, and the preliminary design was finished in 1964 by NCP of Britain. The detailed design was completed in 1969 by SGN of France, and the training of operators was carried out in parallel with this in France. The results of the safety investigation was approved in Jan. 1970, and the construction was started in June 1971. The site of the reprocessing plant is the eastern part of the Tokai Establishment of PNC. The process adopted is the wet Purex process having been established in large practical plants. The treating capacity is 0.7 t/day. The main processes are acceptance and storage, mechanical treatment, and chemical treatment. The reprocessing facilities comprise the main shop, the analysis station, the main exhaust stack, the decontamination station, the solid waste store, the sea discharge pipe, and other incidental facilities. The construction works were about 7 months behind the schedule when the water flow test was finished. The chemical test was finished in March, 1975, and the uranium test is in progress since Sept., 1975. The problems for future are the developments of effective waste treatment and storing techniques, and the researches have been carried out by PNC. The construction project of the second plant is urgently required, since it takes 10 years from planning to operation.

32117 Mathematical modelling of nuclear fuel extraction reprocessing. 5. Uranium and plutonium separation by reextraction method by weakly acid. Rozen, A.M.; Zel'venskii, M.Ya. *At. Energ. (USSR);* **41**: No. 2, 95-98(Aug 1976). (In Russian).

Published in summary form only; for English translation see the journal Sov. J. At. Energy.

32118 Reprocessing: right to pause and think. *Nature (London);* **264**: No. 5588, 691-692(23 Dec 1976).

The subject discussed is the question of whether to push ahead further with the reprocessing of nuclear fuels. This question is under close scrutiny both in the UK and the USA. In the USA a moratorium has been called on reprocessing and the export of reprocessing technology; this has been followed by a similar decision by France, and a decision is shortly expected from Canada. The three concerns of growth, energy requirements, and the environment, are now acting to reinforce each other in the public sector, and the focus they have found is nuclear power. At the heart of matters is the question of whether a fast breeder reactor system should be developed, but it is pointed out that if such reactors do not receive the 'green light' it does not follow that reprocessing thermal reactor fuels is unimportant.

32119 Reprocessing (1): Barnwell, USA. An inevitability forestalled. Norman, C. *Nature (London);* **264**: No. 5588, 693-694(23 Dec 1976).

The matter discussed is whether the US Administration will allow a large reprocessing plant, located in a South Carolina forest, to start operations. Constructed by private industry at a cost so far of some 250 million dollars, this facility could become either a key component in the US nuclear power programme, or a massively expensive white elephant. Designed as the first full-scale commercial plant to reprocess spent fuel from power reactors, the facility is falling victim to rising concerns about the proliferation of nuclear weapons, and its fate will probably hang on a complex series of regulatory, political and diplomatic decisions expected to be taken in the near future. Even if the Administration decides to allow the plant to start operations, however, its problems will not be entirely over. Before it can operate at full capacity additional facilities to solidify highly active wastes from the plant and to convert Pu nitrate to oxide will be required, estimated to cost 500 million dollars, a sum that private industry says it is unwilling to risk without government assistance. The plant is designed to reprocess fuel continuously from about 50 commercial power reactors, extracting Pu and U and recycling the materials as new reactor fuel. Activities of environmental and anti-nuclear groups with regard to large scale Pu production are discussed, together with the findings of the US Nuclear Regulatory Commission, including the holding of public hearings. Political developments are also discussed, including the establishment of international controls. The conclusion is reached that the future for reprocessing in the USA is uncertain.

32120 Nuclear reactor fuel element splitter. Yeo, D. (to Westinghouse Electric Corp.). US Patent 4,000,391. 28 Dec 1976. Filed date 27 Aug 1974. 8p.

A method and apparatus are disclosed for removing nuclear fuel from a clad fuel element. The fuel element is power driven past laser beams which simultaneously cut the cladding lengthwise into at least two longitudinal pieces. The axially cut lengths of cladding are then separated, causing the nuclear fuel contained therein to drop into a receptacle for later disposition. The cut lengths of cladding comprise nuclear waste which is disposed of in a suitable manner. 6 claims, 10 drawing figures.

32121 Processing and reprocessing of fuel. IV. Walton, G.N. (Imperial Coll. of Science and Technology, London (UK)). pp 67-77 of In Nuclear reactors. To breed or not to breed. Rotblat, J. (ed.). London; Taylor and Francis (1977).

The subject is discussed under the following heads: processing cycles (fuel processing cycle as at present operated in the UK); Pu and U stocks in UK; details of processing plant (Windscale primary separation plant for the recovery of U and Pu from irradiat-

ed fuel elements); burnup and processing; processing for fast breeder reactor fuel; multiple neutron capture and its effect on processing required; concentration of products; and hold-up time. It is considered that processing plants should be designed (a) to avoid movement and exposure of separated Pu; and (b) to process completely not only high level wastes, but also low level and medium level waste in all its forms.

32122 (BNWL-tr—228) **Pyrochemical pretreatment of fuels derived from fast power reactors: oxidation with fused alkaline nitrates.** Avogadro, A.; De Plano, A. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). Jan 1977. Translation of EUR—4784. 25p. Dep. NTIS $3.50.

Oxidation with fused nitrates of irradiated UO_2-PuO_2 permits the elimination of volatile fission products and makes the fuel more easily soluble in mineral acids. This pretreatment can be carried out after a short cooling period, thereby reducing the expense of immobilizing the large amount of plutonium present in fast reactor fuel. Results of laboratory experiments on the oxidative disaggregation of the mixed oxide, on the thermal and radiolytic stability of fused nitrates, and on the behavior of some of the most significant fission products are described in this report.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 32104

32123 **Fissionable mass storage device.** Bevilacqua, F. (to Combustion Engineering, Inc.). US Patent 4,004,154. 18 Jan 1977. Filed date 17 Mar 1975. 6p.

An apparatus for the safe storage of a plurality of fissionable masses including an array of discrete neutron absorbing shields which utilizes the principle of the neutron trap to reduce the multiplication factor of the storage array to a subcritical value when immersed in a neutron moderating medium is claimed. Each discrete neutron absorbing shield is designed to perimetrically encircle each of the stored fissionable masses. Each shield is spaced such that the encircled fissionable mass is spaced from the next adjacent neutron absorbing shield by a distance determined by the enrichment of the fissionable masses and attenuation of the moderating medium. 6 claims, 3 drawing figures.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 32084

32124 **Uranium purchasers reassert their influence.** Braatz, U. (Vereinigung Deutscher Elektrizitaetswerke e.V. (VDEW), Frankfurt am Main (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **21**: No. 11, 539-540(Nov 1976). (In German).

The growing uranium requirement in the Western world in the long run can be met only by a participation of the electricity generating industry and the governments of the participating countries in the development costs of new deposits, according to statements by leading representatives of the uranium producers and consumers at a symposium organized by the Uranium Institute in the summer of 1976. On the other hand, the uranium market is likely to get under more and more pressure because of the delays in nuclear power programs worldwide. It is probable that the price of uranium will soon have reached its peak for a long time to come. Uranium producers also will have to bear in mind that a price policy which makes the use of uranium unattractive compared with other sources of energy could well result in a situation in which the largest uranium consumers would build more conventional thermal power stations to bridge the time to commercial introduction of fast breeder reactors.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 32070, 32105, 32724

32125 (ARH-LD—152A) **Atlantic Richfield Hanford Company: process technology and process development. Quarterly report, October 1976—December 1976.** (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-2130. 150p. Dep. NTIS $6.50.

This quarterly report is the third in a series intended to provide information on research and engineering activites being performed to improve the processing of irradiated reactor fuels, the production of plutonium, and the management of resultant chemical wastes.

32126 (PNC-J—265-75-01) **Behavior and removal of tritium in coolant sodium in fast breeder reactors.** Shinagawa, M.; Nishizawa, K.; Sonoi, K.; Mori, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Apr 1975. 122p. (In Japanese). TIC. 180 refs.

Tritium is produced by binary and ternary fission in fast breeder reactors. Moreover, tritium is produced by nuclear reaction of boron and litium with neutrons. Some of the produced tritium diffuses from primary coolant to the environment through the cover gas or secondary coolant and steam generator, therefore it is necessary to develop the removal techniques of tritium from sodium and to evaluate precisely the environmental radioactivity. The literature survey of tritium behavior in liquid metal was carried out in order to develop above the mentioned techniques. The contents of the report is classified into the following four items: (1) The behavior of tritium in sodium (2) The behavior of tritium in lithium (3) Instrumentation, analysis and monitoring of tritium (4) Storage of krypton which affects seriously the atmospheric radioactivity.

32127 **Management of radioactive wastes from the nuclear fuel cycle. Report on the international symposium held in Vienna from 22 to 26 March 1976.** Lennemann, W. (International Atomic Energy Agency, Vienna (Austria)). *At. Energy Rev.;* **14**: No. 2, 421-429(1976).

The papers presented at the symposium are reviewed. The topics covered include the waste management policies of several countries, the techniques of separating gaseous radionuclides, the treatment of wastes at different radioactivity levels, and sea and land disposal. The proceedings of the symposium are to be published by the International Atomic Energy Agency.

32128 **Management of wastes from the LWR fuel cycle.** Cabe, L. (Pollution Prevention (Consultants) Ltd., Crawley (UK)). *Nucl. Eng. Int.;* **21**: No. 250, 69-74(Nov 1976).

Views expressed at the ERDA International Symposium on the Management of Wastes for the LWR Fuel Cycle are presented. Establishing the back end of the fuel cycle (reprocessing and waste management) is the most urgent problem currently facing the nuclear industry. The industry is tending to criticize governments for not taking care of this responsibility. Now most governments are recommending storage of high level wastes until ultimate disposal methods are decided. This may be the best engineering approach, but it does not silence nuclear critics. One view at the Denver conference was that the only way to satisfy them is to quickly establish a disposal method, even though it may not be the most satisfactory or economic.

32129 **Radioactive waste management in the United Kingdom. Chapter 5.** Clelland, D.W. (British Nuclear Fuels Ltd., London). pp 79-88 of In Nuclear reactors. To breed or not to breed. Rotblat, J. (ed.). London; Taylor and Francis (1977).

A nuclear fuel cycle is described briefly. A speculative UK nuclear programme for the period up to the year 2000 is shown. A summary is given of waste management under the headings; highly-active liquid waste, medium-active liquid waste, low-active liquid waste, highly-active solid waste, low-active solid waste, and gaseous waste.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 32109

32130 (DP—1444) **Evaluation of ^{137}Cs sorbents for fixation in concrete.** Plodinec, M.J. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract E(07-2)-1. 25p. Dep. NTIS $3.50.

As part of the long-term waste management program at the Savannah River Laboratory, several ^{137}Cs sorbents were evaluated for incorporation into concrete. The sorbents studied were: Linde AW-300, AW-500, 13-X, and SK-40; Norton Zeolon 200, 500, and 900; clinoptilolite; and vermiculite. The parameters studied were sorption kinetics, leachability, and compressive strength of the concrete. The best sorbents identified were Linde AW-500 and Norton Zeolon 900. In all tests, these two sorbents performed almost identically; sorption kinetics were acceptable; both strengthened the concrete, and both gave relatively leach-resistant concrete. Vermiculite that had been heated to collapse its lattice around ^{137}Cs gave the most leach-resistant concrete. However, it sorbed cesium slowly, and the resulting concrete was very weak. When silica gel was added to concrete to react with free calcium, the addition had no effect on cesium leachability.

32131 (JAERI-M—6284) **Calculation code; REPROSY-P for process studies on Pu purification with TBP.** Tsujino, T.; Kohsaka, A.; Aochi, T. (Japan Atomic Energy Research Inst., Tokyo). Oct 1975. 33p. NTIS (US Sales Only).

To evaluate the plutonium purification process with tributhyl phosphate (TBP), the calculation code; REPROSY-P for TBP-HNO_3-Pu system, has been prepared on the basis of a batchwise counter-current extraction cascade model. With the code, the concentration profiles under transient or steady state condition and the

number of theoretical stages required, can be calculated for a given process condition. Empirical distribution equations, distribution data of plutonium, and the detailed calculation program are described.

32132 (NUKEM—73) **Removal of radioactive residues from nuclear power plants. Pt. 1,2. Text. Appendices. Period: 1.1.70-31.12.71.** Witte, H.; Herzog, J.; Christ, R. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.); Transnuklear G.m.b.H., Hanau (Germany, F.R.)). Apr 1972. vp. (In German). TIC.

With figs., tabs. and refs. Available from ZAED.

The radioactive residues deposited from the coolant purification and waste water processing of nuclear power plants are investigated regarding their quantity and specific activity. It is found in agreement with the safety specifications valid for the storage in the salt mine ASSE that it is partly necessary and partly, to a large extent, desirable to fix the residues to insoluble binders. There are also other methods besides the fixing process for conditioning the residues which only involve drying-up of the residues. The drying process in the nuclear power plant may be the most economical to carry out; however, an overall consideration of the process chain transport - conditioning - final storage shows that the fixing in a large central plant for the waste disposal of several nuclear power plants is technically the most economical and simultaneously the safest way of removing residues. Bituminization is the most economical process here.

32133 Separation method for ions of elements of the III., IV., VI. and VIII. groups of periodical system. Marhol, M. Czech Patent 148,842. 15 May 1973. 3p. (In Czech).

A method is described of concentrating and separating the ions of the elements of the IIIrd, IVth, and VIIIth groups of the periodic system by ion exchangers to which the ions are double-bonded. The new type of ion exchangers applied consists of the polycondensates of phenol with aldehydes or ketones, or of the polymers of substances with a double bond and containing an atom of phosphorus, arsenic or antimony and an atom of sulphur or oxygen in their molecule. The method described may be used to advantage for the removal of the ions of uranium, thorium and its daughters, lanthanum, yttrium, and iron from waste waters.

32134 Separation method for ions of elements of the III., IV., VI. and VIII. groups of periodical system. Marhol, M. Czech Patent 148,841. 15 May 1973. 2p. (In Czech).

The method is presented of separating the ions of the elements of the periodic system groups III, IV, and VIII by ion exchangers. The ions are complex-bonded to a new type of ion exchanger consisting of the polycondensates of phenol with aldehydes or ketones and containing an atom of phosphorus, arsenic or antimony with an atom of sulphur or oxygen in a complex bond. The polymers of compounds containing a double bond, e.g., of butadiene, polyvinyl alcohol, polyethylene, polypropylene, and the compounds of styrene with fural may also be used for this purpose. The method is demonstrated on a case of uranium and heavy metal concentration and the separation thereof from waste waters.

32135 Method of separation of krypton from the off-gas produced during the burn-up of nuclear fuel or blanket assemblies containing graphite. Merz, E.; Beauyean, H.; Laser, M.; Vygen, H.; Barnert-Wiemer, H. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,437,810/B/. 21 Aug 1975. 2p. (In German).

Nuclear fuel or blanket elements of high-temperature reactors, embedded in a graphite matrix or coated with pyrolytic carbon, produce off-gases during burn-up containing Xe and Kr besides CO_2, N_2, O_2, and CO. For separating the krypton, expensive installations are necessary up to now. According to the invention, Kr can be separated in a simple manner from the off-gas liquefied by compression or cooling by rectifying the liquid gas under a pressure corresponding to the saturation vapor pressure of the present mixture of nitrogen, oxygen, and carbon monoxide.

32136 Radioactive waste calcination process. Kilian, D.C. (to Energy Research and Development Administration). French Patent 2,284,959/A/. 10 Sep 1975. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 10 Sep 1974, US.

The method presented reduces the volatility of chlorides when a liquid containing sodium ions, nitrate ions and chloride ions is solidified by calcination in a fluidized bed calcination furnace. The process consists of: introduction of zirconium and fluoride into the liquid, addition of about half a mole calcium nitrate per mole of fluoride present and calcination of the mixture to form a calcine of high apparent density containing the chloride so that this latter is bound and its volatility reduced. The calcination temperature lies between 475 and 525°C. For the calcination of medium-level radioactive wastes the process involves the addition of zirconium fluoride wastes to these radioactive wastes, the addition of half a mole calcium nitrate per mole of fluoride from the zirconium fluoride wastes, and calcination of the mixture at about 500°C to form a calcine of high apparent density containing the chloride. This process can be used to convert liquid radioactive wastes into solids for long-term storage by calcination of the liquids in a fluidized bed calcination furnace.

32137 Method and system for the reprocessing of contaminated water for washing, in particular in nuclear power stations. Queiser, H.; Meichsner, O. (to Licentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 2,414,728/A/. 27 Nov 1975. 15p. (In German).

1 fig.

It is suggested to employ a combination of ion exchange and filtration for reprocessing radioactively contaminated water for washing, by adding ion exchange resins - including resins no longer usable in passing-through operation mode - to the water for washing, the suspension being then filtrated by a mechanical filter, and the filter cake being dried. Then, it can be guided directly to final storage. A plant using this method is described.

32138 Decontamination of uranium-mine waste water from Ra by means of biosorbent. Prochazka, H.; Stamberg, K.; Jilek, R.; Fuska, J.; Katzer, J. (Veterinary Research Institute, Brno (Czechoslovakia)). pp 531-533 of In Physics in industry. O'Mongain, E.; O'Toole, C.P. Oxford; Pergamon Press (1976).

From International conference on physics in industry; Dublin, Ireland (9 Mar 1976).

The decontamination of waste water from uranium mining and milling industry will become one of the limiting factors in its further development for energy production in the near future. Moreover, the shortage of fossil fuels, especially oil, which is an important source of raw materials for the chemical industry also forces scientists to develop both new sorbents from untypical natural materials and new effective technological procedures of waste water treatment. In recent years a working team has been concerned with reutilization of some waste products for the purposes mentioned and the results of it are: (1) biosorbents, new sorptionable materials prepared from chemically treated fungal biomass, for example the waste biomass resulting from Penicillin production; (2) the sorbent-precipitation process onto the biosorbent, a suitable decontamination technology.

32139 Method for reovering uranium from residual solution. Brandberg, S. (to ASEA-ATOM AB). Swedish Patent 385,341/B/. 21 Jun 1976. 5p. (In Swedish).

A method is given for recovering uranium from a residual solution provided by an installation for the manufacture of a nuclear fuel from uranium hexafluoride in the presence of ammonia by eliminating the fluorides of the residual solution. The method is characterized by the steps of precipitating the fluorides of the residual solution through adding a powdered alkaline earth carbonate, and of recovering uranium from the residual solution thus free from fluorides.

32140 Method for embedding granulated or spent ion-exchanging organic substances in concrete. Christensen, H.; Jejes, P. (to ASEA-ATOM AB). Swedish Patent 387,190/B/. 30 Aug 1976. 4p. (In Swedish).

A method is claimed of embedding in concrete a spent ion-exchanging organic substance originating from a scrubbing-circuit of a nuclear reactor. Prior to solidification of the mixture, a substance is incorporated with the substance that is capable of preventing water in the grains of the ion-exchanging substance from penetrating into the solidified product.

32141 Radwaste disposal by incorporation in matrix. Curtiss, D.H.; Heacock, H.W. (to United Nuclear Industries, Inc.). US Patent 3,988,258. 26 Oct 1976. Filed date 17 Jan 1975. 6p.

A process of safe disposal, handling, or storae of radwaste associated with nuclear power productin is described. A feature of the invention is to incorporate the radwaste in a hardenable, matrix-forming mass employing a cement-type binding agent to which alkali or alkaline-earth silicate is added, among other things, to increase liquid absorption. 9 claims.

32142 Treatment of waste water from uranium ore preparation. Klicka, V.; Mitas, J.; Vacek, J. (to Vyzkumny ustav chemickych zarizeni). US Patent 3,988,414. 26 Oct 1976. Filed date 17 Dec 1974. 6p.

An improved closed-loop process is described for treating waste water resulting from chemical extraction of uranium from ore. The water is evaporated to form a concentrated solution and is then subjected to crystallization of the least soluble salt component thereof via further evaporation, or cooling or simultaneous cooling and a partial vacuum. The crystallized component is then separated from the mother liquor, whereupon the latter is fed back after removal of residual uranium therefrom to the extraction installation to replace the acids used therein. Additionally, the pure condensate produced during evaporation of the waste waters is employed as a replacement

for the fresh water employed in processing of the ore. 6 claims, 2 figures.

32143 World-wide push to early solidification of high-active liquid waste. *Nucl. Eng. Int.;* **21**: No. 250, 63-66(Nov 1976).

Intense scientific effort is being directed at developing high-active liquid waste solidification processes in India, France (rotary calciner), West Germany (vera), USA (spray calciner) and UK (Harvest). BNFL replies to questions by the Nuclear Installation Inspectorate concerning which problems remain to be solved in vitrification technology. of particular interest at the moment are the new glass formulations, their leach resistance rates and their ability to stand up to α damage. The Harvest process is illustrated.

32144 Continuous vitrification in France taken to industrial plant scale. Bonniaud, R. *Nucl. Eng. Int.;* **21**: No. 250, 67-69(Nov 1976).

Early work in France in high-level radioactive waste solidification is summarised. The pot technique is outlined. The continuous vitrification process chosen for the Marcoule vitrification plant (AVM) is described. Details are given of the plant and its operation. Differences between the plant planned for La Hague (AVH) and the Marcoule plant are outlined.

32145 Preparation for storage of fission products. De Bacci, M.; Price, M.S.T. (to United Kingdom Atomic Energy Authority). US Patent 3,994,822. 30 Nov 1976. Priority date 8 Feb 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A method of preparing waste fission products for storage comprises combining graphite powder and a carbonaceous binder into one component, mixing this component with alpha-silicon carbide, and sprinkling this mixture on to waste fission product particles as the particles are tumbled in the presence of a solvent to form a tacky "overcoating" around the particles. The "overcoated" particles are warm pressed to form a "green" body, then the temperature is raised to carbonize the binder. The body is then heated at an elevated temperature in contact with silicon so as to melt the silicon and impregnate the body, to form a matrix of beta-silicon carbide enclosing the waste fission product particles by reaction-sintering. 6 claims.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 32132

32146 (AERE-M—2829) **Recovery and disposal of sodium potassium alloys from irradiated rigs.** Jones, D. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Aug 1976. 6p. NTIS (US Sales Only).

Available from H.M. Stationery Office, price Pound1.00.

The higher chemical activities and lower melting points of potassium sodium alloys used in MTR rigs have necessitated a modification of the procedures previously employed for sodium-filled MTR capsule disasssembly. Tests showed that up to 14 g of 80:20 wt % NaK could be removed in an air cell and reacted with water for disposal with acceptable flames and small explosions. This procedure was not considered safe for larger capsules containing 300 to 400 g of 60:40 wt % NaK, and a facility was developed incorporating a nitrogen filled alpha box. Component cleaning and NaK reaction were carried out very innocuously with a steam jet. This facility now permits swift routine recovery and disposal of active NaK alloys.

32147 (CEA-CONF—3523) **Radioactive waste disposal.** Cluchet, J.; Roger, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements). Oct 1975. 14p. (In French). TIC.

From Information meeting on industrial wastes and by-products; Lyon, France (25 Nov 1975).

After mentioning the importance of the problem of the disposal of wastes produced in the electro-nuclear industry, a short reminder on a few laws of radioactivity (nature and energy of radiations, half-life) and on some basic dosimetry is given. The conditioning and storage procedures are then indicated for solid wastes. The more active fractions of liquid wastes are incorporated into blocks of glass, whereas the less active are first concentrated by chemical treatments or by evaporation. The concentrates are then embedded into concrete, asphalt or resins. Storage is done according to the nature of each type of wastes: on a hard-surfaced area or inside concrete-lined trenches for the lowest radioactivity, in pits for the others. Transuranium elements with very long half-lives are buried in very deep natural cavities which can shelter them for centuries. From the investigations conducted so far and from the experience already gained, it can be concluded that safe solutions are within our reach.

32148 (DEU—76-35) **Transport of radioactive high level waste to the sun.** (Dornier-System G.m.b.H., Friedrichshafen (Germany, F.R.)). 1972. 40p. (In German). TIC.

With figs. and tabs.

First results on the feasibility of the disposal of high-level waste from reprocessing plants for LWR fuel elements are presented. The emphasis is on the transport of the waste to the sun by means of existing and planned carrier systems and on a mission-specific upper stage (AMOS). The article discusses transition orbits earth-sun, gravitation losses, suitable carrier systems, design criteria, types of propulsion (radioisojet with hydrogen as propulsion gas), safety aspects and costs. It arrives at the conclusion that the transport of radioactive high-level waste to the sun by means of spacecraft technology appears feasible for the future and that the costs are not too high. It is pointed out that this project can only be carried out in international cooperation.

32149 (ORNL/Sub/4112—25) **Investigation of the utility of Gulf Coast salt domes for the storage or disposal of radioactive wastes.** Martinez, J.D.; Thoms, R.L.; Kupfer, D.H. (Louisiana State Univ., Baton Rouge (USA). Inst. for Environmental Studies). 30 Sep 1976. Contract W-7405-ENG-26;SUB-4112. 321p. Dep. NTIS $9.75.

Analysis of tectonic, geohydrologic, and cultural data led to the selection of three salt domes (Vacherie, Rayburn's, Prothro) in the North Louisiana Basin and three (Keechi, Mt. Sylvan, Palestine) in the Northeast Texas Basin. Results of the tectonic stability studies (monitoring of dome movement, quaternary, Mesozoic and Tertiary, seismic, corehole in Vacherie) and hydrologic stability studies (numerical modeling, caprock, mine leaks) are discussed in detail and recommendations for further study are given. (DLC)

32150 (TRITA-KKE—7601, pp 13-14) **Some aspects on the use of knowledge in radiation chemistry for the work on highly radioactive rock deposits.** Westermark, T. 1976.

From 5. meeting on radiation research and radiation technology; Vemdalsskalet, Sweden (9 Feb 1976).

Published in summary form only.

In 5. meeting Nordic society for radiation research and radiation technology, Vemdalsskalet, Feb 9-11, 1976.

32151 (UCRL—52199) **Survey of naturally occurring hazardous materials in deep geologic formations: a perspective on the relative hazard of deep burial of nuclear wastes.** Tonnessen, K.A.; Cohen, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jan 1977. Contract W-7405-ENG-48. 17p. Dep. NTIS $3.50.

Hazards associated with deep burial of solidified nuclear waste are considered with reference to toxic elements in naturally occurring ore deposits. This problem is put into perspective by relating the hazard of a radioactive waste repository to that of naturally occurring geologic formations. The basis for comparison derives from a consideration of safe drinking water levels. Calculations for relative toxicity of FBR waste and light water reactor (LWR) waste in an underground repository are compared with the relative toxicity indices obtained for average concentration ore deposits. Results indicate that, over time, nuclear waste toxicity decreases to levels below those of naturally occurring hazardous materials.

32152 Disposal of liquid radioactive waste - discharge of radioactive waste waters from hospitals. Ludwieg, F. (Gewerbeaufsicht des Landes Nordrhein-Westfalen, Duesseldorf (Germany, F.R.). Zentralstelle fuer Sicherheitstechnik, Strahlenschutz und Kerntechnik). pp 233-241 of In Der ermaechtigte Arzt im Sinne der Strahlenschutzgesetzgebung. Spezielle Beitraege der Medizin zum Strahlenund Umweltschutz. Braun, H. (ed.). Stuttgart; Thieme (1976). (In German)

From Annual meeting of the Fachverband fuer Strahlenschutz e.V.; Helgoland, Germany, F.R. (27 Sep 1974).

3 tabs.; 20 refs.

A survey is given about legal prescriptions in the FRG concerning composition and amount of the liquid waste substances and waste water disposal by emitting into the sewerage, waste water decay systems and collecting and storage of patients excretions. The radiation exposure of the population due to drainage of radioactive waste water from hospitals is lower by more than two orders than the mean exposure due to nuclear-medical use.

32153 Reprocessing (2): Windscale, UK. 'The β-in-air alarm is a yodel sound'. Boucher, G. *Nature (London);* **264**: No. 5588, 695-696(23 Dec 1976).

The controversy aroused by the recently reported leak of weakly radioactive water from an old concrete silo containing solid wastes stored in water at the UKAEA Windscale Works is reported. The implications for major nuclear decisions that will soon have to be made are considered.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 32073, 33191, 33193, 33194, 33253

32154 Fox with a nuclear bite. Patterson, W. *New Sci.;* **72**: No. 1027, 379-380(18 Nov 1976).

The findings of the Fox commission, which has been enquiring into the environmental implications of the development of uranium deposits in the Northern Territory of Australia, are discussed. The report is very cautious and suggests that there should be ample time for public consideration and debate. It is pointed out that there are many similarities between the Fox report and the recent Flower's report on nuclear power and the environment in Britain.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 32098

32155 (INIS-mf—3331, pp 74) **Exposure parameters and some properties of erythrocytes of uranium miners.** Vich, Z.; Prochazka, J.; Brychtova, V.; Safandova, M. (Zavodni Ustav Narodniho Zdravi Uranoveho Prumyslu, Pribram (Czechoslovakia)). [nd]. (In Czech).

From National radiobiological conference and scientific conference of the Institute of national health in uranium industry; Pribram, Czechoslovakia (17 May 1976).

Published in summary form only.

In National radiobiological conference and scientific conference of the Institute of national health in uranium industry .

32156 (NTIS/PS—76/0786) **Accident risks in nuclear facilities (a bibliography with abstracts). Report for 1964-Sep 76.** Grooms, D.W. (National Technical Information Service, Springfield, Va. (USA)). Oct 1976. 200p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/659.

The bibliography presents risk analysis and hazards evaluation of the design, construction and operation of nuclear facilities including the risk and hazards of transporting radioactive materials to and from these facilities. Radiological calculations for environmental effects of nuclear accidents are included. (This updated bibliography contains 195 abstracts, 64 of which are new entries to the previous edition.) (GRA)

REGULATIONS

32157 (KFK—2295) **Annual report 1975.** Bork, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Spaltstoffflusskontrolle). Aug 1976. vp. (In German). NTIS (US Sales Only) $7.75.

With figs., tabs. and refs.

Topics discussed include: Systems-analytic work on material balance and data verification, on the game-theoretical treatment of multiple inventory problems, and on the application of the principle of material balance to other problems; non-destructive and direct (automation) methods of ^{235}U and ^{239}Pu determination. Security of nuclear material and plants; experimental testing of monitoring measures; work connected with the introduction of control measures in nuclear facilities after the verification agreement concerning the NP treaty; international cooperation (in particular ESARDA, IAEA).

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 32889

32158 (LA—6675-PR) **Nuclear safeguards research program status report. Progress report, May—August 1976.** (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 50p. Dep. NTIS $4.50.

This report presents the status of the two Nondestructive Assay Research and Development programs pursued by the LASL Nuclear Safeguards Research Group R-1. Salient topics of the two programs are: assay applications and results, instrument development and measurement controls, and DYMAC (Dynamic Materials Control).

32159 (ERDA-tr—246) **Norms for physical protection of nuclear material for the Rumanian Republic.** Ursu, I. 1976. Translation of a decision published in the Official Bulletin of the Socialist Republic of Romania, No. 42, May 1976. 25p. Dep. NTIS $3.50.

This document pertains to the physical protection of nuclear materials in Romania. The five chapters discuss the components of protection systems, classification of nuclear material, provisions for protection of nuclear material during use and storage, and regulations for protection during transport. (DLC)

32160 **Nuclear data for safeguarding of nuclear material. The present situation and prospection about the use of nuclear data.** Tamura, T.; Umezawa, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Genshiryoku Kogyo;* 22: No. 2, 38-40(Feb 1976). (In Japanese).

Nuclear energy must be used only for peaceful purposes, so the diversion of nuclear materials for other purposes must be detected early. In the safeguards of nuclear materials, therefore, the methods of measuring nuclear materials by means of their nuclear characteristics are being developed. The kinds of nuclear data utilized and the accuracy of nuclear data required for the technology development are described as follows: measuring techniques and nuclear data; passive assays such as α and γ spectrometries, etc.; active assays like neutron and photon interrogations; and isotope correlation.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

32161 (IS-T—739) **Connection of a He-jet recoil transport system to an ion source.** Sheppard, G.A. (Ames Lab., Iowa (USA)). Feb 1977. Contract W-7405-ENG-82. 53p. Dep. NTIS $4.50.

Thesis.

In an effort to make non-gaseous fission products available for on-line separation and study with the TRISTAN facility, an investigation of the operational characteristics of a He-jet recoil transport system and a TRISTAN-type ion source was conducted after interfacing them with a skimmer. So that experimental results could be understood and controlled, studies of the dynamics of choked flow in a capillary and of the transport characteristics were made. Satisfactory performance of the He-jet system was obtained, but large temperature and pressure gradients thwarted early attempts to efficiently couple the He-jet to the ion source. The pressure-related difficulties have been overcome by employing a skimmer to remove extraneous gases before injection of the activities into the ion source, but efforts to conquer the temperature-related problems continue.

HEAVY WATER PRODUCTION

REFER ALSO TO CITATION(S) 32920

RADIATION SOURCES

32162 **X-ray beam flattener.** Schriber, S.O. (to Atomic Energy of Canada Ltd.). US Patent 4,006,361. 1 Feb 1977. Priority date 18 Dec 1974, Canada. 4p.

An x-ray beam flattener of predetermined symmetrical shape for attenuating the radiation intensity of the beam in decreasing amounts as the angle from the central axis increases is described. The symmetrical shape is made from a low Z, high density material such as Al_2O_3, BeO, $BeAl_2O_4$, B_4C or SiC. A further thin layer of high Z material may be coated on the forward end of the symmetrical shape to absorb low energy photons.

DESIGN AND FABRICATION

32163 **High energy electron irradiation of flowable materials.** Offermann, B.P. (to Licentia Patent-Verwaltungs-G.m.b.H.). US Patent 3,988,588. 26 Oct 1976. Priority date 29 Nov 1972, German, Federal Republic of (F.R. Germany). 6p.

In order to efficiently irradiate a flowable material with high energy electrons, a hollow body is disposed in a container for the material and the material is caused to flow in the form of a thin layer across a surface of the body from or to the interior of the container while the material flowing across the body surface is irradiated.

32164 **Apparatus for the irradiation of fluids.** Graentzel, A. US Patent 4,002,918. 11 Jan 1977. Priority date 10 Apr 1975, German, Federal Republic of (F.R. Germany). 6p.

An apparatus for the irradiation of fluids in which the fluid is conducted along the walls of a container having walls which are permeable for the radiation to which the fluid is exposed is described. Radiation sources are arranged around the container and a rotor is disposed within the container. The rotor consists of a body having axial bores and pins movably disposed in the bores and adapted to engage with their front ends the container walls to wipe any deposits from the container walls during rotation of the rotor.

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 33046

ISOTOPIC POWER SUPPLIES

REFER ALSO TO CITATION(S) 33192

32165 (TID—27382) **Biomedical engineering support. Annual progress report, August 15, 1975—August 14, 1976.** Kolff, W.J.; Smith, L.M.; Sandquist, G. (Utah Univ., Salt Lake City (USA)). Dec 1976. Contract EY-76-S-02-2155.A001. 102p. Dep. NTIS $5.50.

The basic goal of the ERDA Artificial Heart Program is to develop and fabricate an Artificial Heart System for animal experiments. These future experiments and studies would be directed at developing and evaluating a satisfactory radioisotope-powered system for total heart replacement in humans. Research progress is reported on the program including 11 total heart replacement experiments performed in calves using the ERDA blood pump powered by an electric motor implanted in the abdomen. (TFD)

DESIGN AND FABRICATION

32166 (PB—256969) **Continued evaluation of cardiac pacemakers. Annual report Jun 73-31 Aug 75.** Brueschke, E.E.; Uretz, E.F.; Hauser, R.G. (IIT Research Inst., Chicago, Ill. (USA)). 27 May 1976. Contract N01-HT-9-2125. 30p. NTIS (US Sales Only) $4.00.

See also report dated Mar 75, PB-243 490.

The nuclear powered pacemaker evaluation was designed to characterize the operating characteristics of such pacemakers and identify potential failure mechanisms. More than 30 nuclear powered pacemakers were implanted in dogs and 15 were subjected to high stress bench tests. This evaluation resulted in the identification of several basic pacemaker problem areas for the batteries under test. These included abrupt and gradual nuclear battery failures, weld seam defects (in one model) resulting in pulse generator failures, pulse generator lead connector defects and pulse generator electronic malfunctions. (GRA)

32167 (TID—27373) **Quality assurance program supplement for ERDA—Brayton Isotope Power System (BIPS).** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 19 Nov 1975. Contract EY-76-C-03-1123. 10p. Dep. NTIS $3.50.

The procedures used by AiResearch to comply with ERDA Quality Assurance Specification SNS-1, Rev. 1 for the Brayton Isotope Power System are described. (TFD)

32168 **Thermoelectric generator with hinged assembly for fins.** Purdy, D.L.; Shapiro, Z.M.; Hursen, T.F.; Maurer, G.W. (to ARCO Medical Products Co.). US Patent 3,989,546. 2 Nov 1976. Filed date 11 Mar 1974. 10p.

A cylindrical casing has a central shielded capsule of radioisotope fuel. A plurality of thermonuclear modules are axially arranged with their hot junctions resiliently pressed toward the shield and with their cold junctions adjacent a transition member having fins radiating heat to the environment. For each module, the assembly of transition member and fins is hinged to the casing for swinging to permit access to and removal of such module. A ceramic plate having gold layers on opposite faces prevents diffusion bonding of the hot junction to the shield.

32169 **Thermoelectric generator having a resiliently mounted removable thermoelectric module.** Purdy, D.L.; Shapiro, Z.M.; Hursen, T.F.; Maurer, G.W. (to ARCO Medical Products Co.). US Patent 3,989,547. 2 Nov 1976. Filed date 11 Mar 1974. 8p.

An electrical generator having an isotopic heat capsule including a radioactive fuel rod as a primary heat source and thermoelectric modules as converters is described. The biological shield for the capsule is suspended from spiders at each end each consisting of pretensioned rods and defining planes at right angles to each other. The modules are mounted in cups of transition members of a heat rejection fin assembly whose fins extend from both sides of the transition member for effective cooling.

32170 **Radioactive heat source and method of making same.** Elsner, N.B. (to General Atomic Co.). US Patent 4,001,588. 4 Jan 1977. Filed date 17 Jul 1975. 8p.

A radioactive source of heat which is resistant to cremation conditions is made by encapsulating a radioisotope within a containment vessel and forming a refractory metal silicide diffusion coating exterior thereof. A secondary molybdenum vessel may be provided with a molybdenum silicide coating and then heated in air to oxidize its outer layer. A layer is applied exterior of the diffusion-coating which provides a continuous ceramic oxide layer upon subjection to cremation. This outer layer may be discrete silica carried in a hardenable binder of an organic polymer, and a minor amount of antimony is preferably also included.

HYDROGEN

32171 **Equation of state of fluid n—H_2 from P—V—T and sound velocity measurements to 20 kbar.** Mills, R.L.; Liebenberg, D.H.; Bronson, J.C.; Schmidt, L.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* 66: No. 7, 3076-3084(1 Apr 1977).

The molar volume V and ultrasonic velocity u of fluid n—H_2 were measured simultaneously in a piston—cylinder apparatus over the range $75<T<307$ K and $2<P<20$ kbar. An equation of state of the Benedict type was formulated to reproduce the approximately 2000 experimental data sets of V and u within an average deviation of 0.7%. Values of the thermal expansion, compressibility, and heat capacity were derived. The equation was extrapolated beyond its experimental limits to make comparisons with existing static measurements at low pressure and with dynamic experiments and calculations at ultrahigh pressure. This is the first comprehensive high pressure study of the properties of fluid hydrogen, a substance that should prove useful in energy related research.

PRODUCTION

REFER ALSO TO CITATION(S) 31768, 32344

32172 (AD—A029353) **Solid propellants for generating hydrogen. Technical report.** Ayers, O.E.; Murfree, J.; Martignoni, P.; Chew, W.M. (Army Missile Research Development and Engineering Lab., Redstone Arsenal, Ala. (USA). Propulsion Directorate). 20 Apr 1976. 17p. (RK—76-11). NTIS (US Sales Only) $3.50.

Solid propellants have been developed and evaluated in a hydrogen gas generator as potential sources of hydrogen for the hydrogen fluoride/deuterium fluoride chemical laser. Formulations based on the reaction of sodium borohydride ($NaBH_4$) with ferric acid (Fe_2O_3) to produce high purity hydrogen and the reaction of $NaBH_4$ with $(NH_4)2SO_4$ to produce a mixture of hydrogen and nitrogen have been investigated. When deuterated compounds are used in place of the hydrogen-containing compounds, deuterium (D_2) is generated in place of hydrogen (H_2). Propellant grains of $NaBH_4/Fe_2O_3$ weighing approximately 0.08 kg have been prepared and used to generate high purity hydrogen gas for use as a laser cavity fuel and precombustor fuel in a small hydrogen fluoride/deuterium fluoride chemical laser device. The propellant formulations that contain $NaBH_4$ are very stable to moisture, exhibit no sensitivity to impact or friction, and have autoignition temperatures above 773 K. These propellants or similar type solid propellants are potential storable H_2/D_2 gas sources that combine instant readiness with excellent handling characteristics and compact storage. The volumetric efficiency of these solid propellants is equivalent to or greater than that of liquid hydrogen as a source of gaseous hydrogen. Experimental data from the hydrogen fluoride/deuterium fluoride chemical laser tests confirm that hydrogen produced from a solid propellant grain is equivalent to commercial hydrogen for use as a cavity or precombustor fuel in the hydrogen fluoride/deuterium fluoride chemical laser. (Author) (GRA)

32173 **Multistage chemical gas production procedure using radiation.** Gomberg, J.J. (to Texas Gas Transmission Corp.). German(FRG) Patent 2,443,696/A/. 22 May 1975. 17p. (In German).

2 figs.

It is suggested to use a multistage process for producing hydrogen from water, in which process chemical reactions and radiolysis are combined and the radiation of a fusion reaction process instead of the radiation of a decay process is used for radiolysis. All chemical compounds being formed are completely returned into the cycle process. The method, for which a flow diagram is cited, is applicable to the preparation of hydrogen from an earth alkaline salt and water, from calcium bromide and water (at 730°C), and from an earth alkaline halogenide and water.

32174 **Apparatus for the separation and storage of hydrogen gas.** Arntz, F.O.W. US Patent 4,002,553. 11 Jan 1977. Filed date 4 Mar 1976. 6p.

This invention pertains to a new type of method and apparatus for separating, accumulating, compressing and subsequently storing hydrogen gas in a gas column separator system, whereby the lighter and lower density gas hydrogen may be pumped from the top of the column and the change in gas difference, when the higher density and heavier gas appears is sensed thus, automatically stopping the hydrogen gas compressor pump motor unit until the hydrogen gas in the top gas cells is replenished and sensing units probing such hydrogen content subsequently instruct aforementioned hydrogen compressor pump motor unit to resume pumping, such functions being in interaction with the operation of a hydrolyzer unit, water supply pump, storage unit, and power supply means.

32175 **Method for hydrogen generation.** Ishizaka, O. US Patent 4,005,185. 25 Jan 1977. Filed date 10 Apr 1974. 14p.

A method for generating hydrogen is proposed. Metallic zinc or metallic zinc coated with a film of a dissimilar metal, a dissimilar metal oxide, or a dissimilar metal oxide complex is contacted through the medium of an aqueous solution of (i) neutral ammonium carbonate, (ii) neutral ammonium carbonate and an ammonium salt of an inorganic acid, (iii) an ammonium salt of an inorganic acid and

ammonia water, or (iv) neutral ammonium carbonate, an ammonium salt of an inorganic acid and ammonia water with an ammonium complex salt of a metal other than zinc. 9 claims, 1 drawing figure.

ELECTROLYSIS

32176 Apparatus for purifying hydrogen gas. Bunn, J.W. Jr.; Buckley, C.O. (to Trienco, Inc.). US Patent 4,003,725. 18 Jan 1977. Filed date 3 May 1976. 8p.

Pressurized impure hydrogen gas from a hydrogen generator, bottled hydrogen, or other source is fed to a separate palladium purifier unit having an ultrapure hydrogen output for analytical use, and the like. A plurality of palladium-silver tubes are inserted into a jacket tube to form a tube assembly which is coiled around a heated block. The jacket tube receives the impure hydrogen and the palladium-silver tubes pass pure hydrogen which is transferred to an outlet for use, with the gas impurities being discharged at a vent end of the jacket tube.

THERMOCHEMICAL PROCESSES

32177 (UCRL—13711) **Preliminary assessment of economics of hydrogen production from Lawrence Livermore Laboratory ZnSe thermochemical cycle.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Sep 1976. Contract W-7405-ENG-48;PO-329-1803. 239p. (UEC-LLL—760920). Dep. NTIS $8.00.

The ZnSe H_2 Process is a multi-step thermochemical cycle which involves novel selenium-based chemistry and offers, in principle, the possibility of higher energy efficiency than competitive processes based on water electrolysis. A high temperature heat source such as provided by a gas-cooled nuclear reactor is required. The process in the 60,000 lb/hr reference plant design is 26 percent efficient. The H_2 cost is about $28/MM Btu. This amount is considerably above the $5-8/MM Btu estimate for other reported processes for hydrolysis of water. The bulk of the product cost is in capital cost fixed charges. The conceptual capital cost estimate is $3,100 million, consisting of $900 million for the UHTR (Ultra High Temperature Reactor) heat source, and $2,200 million for the ZnSe H_2 process. Selenium and molybdenum availability may be limitations on full scale implementation of the process. (LK)

STEAM REFORMER PROCESSES

REFER ALSO TO CITATION(S) 32197

BIOSYNTHESIS

32178 (PB—259 212) **Survey of hydrogen producing photosynthetic organisms in tropical and subtropical marine environments. Annual report 15 Apr 75-14 apr 76.** Mitsui, A. (Miami Univ., Fla. (USA). Rosenstiel School of Marine and Atmospheric Sciences). 1976. 73p. Q 04/MF/A01.

The research is concerned with the concept of converting solar radiation into a usable fuel, or other product, via a biological conversion system. The study examines the feasibility of exploiting the natural hydrogen gas producing capability of marine photosynthetic microorganisms as a source of fuel for the future. Included is a review of the working hypothesis and the progress made within the first of this two-year plan aimed at estimating the possibility of commercial applications of this concept. The most significant result of the first year's experimentation is the discovery of a blue-green algal species with remarkably high and stable hydrogen photoproduction capability. The discovery of such a strain provides numerous opportunities for further research and application. Subsequent to these experiments, it will now be feasible to conceive of designing a prototype hydrogen production plant, at least on a laboratory scale. (GRA)

PARTIAL OXIDATION PROCESSES

32179 Fuel converting method and apparatus. Kosaka, K.; Ueno, Z.; Nagoaka, T. (to Nissan Motor Co., Ltd.). US Patent 4,004,554. 25 Jan 1977. Priority date 26 Feb 1974, Japan. 8p.

A free hydrogen containing gas is produced from a fuel by a self-operating or -perpetuating expander in which a working member compresses a base mixture of fuel, oxygen or air and water during the compression stroke thereof. The base mixture is heated, after being compressed, by a flame resulting from combustion of a combustible mixture in a combustion chamber to convert the fuel into the gas, and the gas expands to perform work on the working member which accumulates power for the compression stroke of the working member. 11 claims, 2 drawing figures.

STORAGE

REFER ALSO TO CITATION(S) 32174

CHEMISORPTION

REFER ALSO TO CITATION(S) 32673, 32674

32180 Reaction of hydrogen with metallic zirconium monohalides. Struss, A.W.; Corbett, J.D. (Ames Lab., IA). *Inorg. Chem.;* **16**: No. 2, 360-362(Feb 1977).

The metallic halides ZrCl and ZrBr reversibly absorb hydrogen, even at room temperature, to form the discrete but slightly nonstoichiometric phases $ZrXH_{0.5}$ and ZrXH (X = Cl, Br). The reactions were characterized via x-ray powder patterns and equilibrium pressure-composition data between 250 and 400°C. Enthalpies of reaction to form hemi- or monohydrides range from -14.8 to -15.8 kcal/g-atom of hydrogen absorbed while entropy changes (per gram-atom of H) are -15.4 +- 0.2 cu for formation of $ZrHX_{0.5}$ and -20.5 and -19.5 cu for conversion to ZrClH and ZrBrH, respectively. Both enthalpy and entropy values are less than those for formation of the binary metal hydride (delta-$ZrH_{1.8}$), consistent with the expectation that hydride stability is decreased by introduction of a better anion former such as halogen. The stoichiometries and stabilities of the products and the small changes in x-ray powder patterns accompanying the formation of these halide hydrides are consistent with hydride insertion between the double metal layers in the zirconium monohalides.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 32177

PROPERTIES

32181 (AD—A030500) **Further development and application of the lithium nuclear microprobe for hydrogen analysis. Final report 1 Mar 74—1 Jun 75.** Padawer, G.M.; Adler, P.N.; Stauber, M.C. (Grumman Aerospace Corp., Bethpage, N.Y. (USA). Research Dept.). Aug 1976. Contract N00019-74-C-0176. 66p. (RE—522). NTIS (US Sales Only) $4.50.

Continuation of contract no. N00019-72-C-0404.

Experimental studies have demonstrated the unique capability of the Lithium Nuclear Microprobe for Hydrogen (LNMH) technique for the study of hydrogen-related mechanical property degradation and failure in metallic structural components, particularly those used in aerospace applications. This work has been a logical continuation of earlier studies, partially supported by NASC Contract N00019-72-C-0404, through which the LNMH was established as a reliable technique for accurate in situ measurement of localized hydrogen concentrations in material surface regions. Highlights of the present study include analyses of the effect of interfering background on hydrogen measurement sensitivities in different metals and alloys, development of techniques for areal mapping of hydrogen distributions, and probing to greater depths than previously achieved. The LNMH technique was also employed in the study of specific materials problems. Hydrogen concentrations were measured in the surfaces of copper-plated D6AC steel samples to evaluate the levels of hydrogen introduced during the various processing stages in the heat treatment of high strength steels. Especially significant among the applications has been the surface analysis of hydrogen as related to failure diagnostics of aircraft parts. This latter work has included the measurements of localized hydrogen in test fracture regions of nose landing gear axle socket assemblies (Aerospace Materials Specification (AMS) 6407 steel) and in fracture regions of service-failed and test-failed jet engine fan blades (Ti-8Al-1Mo-1V). A number of analysis problems not previously encountered were found. (GRA)

32182 Bubble growth constants for liquid hydrogen and liquid helium. Bald, W.B. (Oxford Univ. (UK). Dept. of Engineering Science). *Cryogenics;* **16**: No. 12, 709-712(Dec 1976).

Bubble growth constants are calculated for liquid H_2 and liquid He at various pressures and liquid superheats for spherically symmetric growth using Scrivens' solution. The constants are shown to be applicable to bubble growth at a heated wall during boiling of cryogenic liquids.

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 31848

32183 Triple point of pure methane. Pavese, F.; Cagna, G.; Ferri, D. (Istituto di Metrologia G. Colonnetti, Turin). pp 281-285 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The triple point temperature and pressure of methane have been measured with high accuracy, using high-purity gas. A primary transportable sealed cell of a model designed by IMGC was employed for triple-point measurements, for permanent use as a fixed point, instead of the IPTS-68 boiling point of oxygen (90.188°K). The following triple-point parameters were found: T = 90.6861 +- 0.0002°K; p = 11696 +- 2 Pa (87.730 +- 0.015 torr). An accuracy evaluation is reported, which takes into account both the effects of single impurities and thermal errors, and a comparison is made with previous realizations. Normal boiling-point temperature was additionally measured, resulting as 111.6567 +- 0.001°K.

32184 Gaseous fuel mixture. White, S.H. (to Anne Joffre White). US Patent 3,989,479. 2 Nov 1976. Filed date 25 Sep 1973. 2p.

A gaseous fuel for use in heating, hardening, welding, cutting, and other working of metals comprises a mixture of about 80 to 82 percent propane, or a propane-butane mixture, about 15 to 17 percent propylene oxide, and about 2 to 4 percent methanol. The fuel gas is generated from a cylinder containing the foregoing mixture under pressure, by being dispensed through a discharge tube reaching to near the bottom of the cylinder and engaging valve means for dispensing the fuel gas mixture. 1 claim, no drawings.

PROPERTIES

REFER ALSO TO CITATION(S) 31872, 31904

32185 Partial combustion process. Staudinger, G. (to Shell Oil Co.). US Patent 3,964,882. 22 Jun 1976. Priority date 19 Oct 1973, Netherlands. 8p.

A partial combustion process is claimed wherein a substantial portion of the soot formed in the combustion reactor is separated from the crude gas, e.g., by hot cyclones, and burned in a separate combustion zone with an excess of oxygen, optionally in the presence of steam, to yield a hot gas containing oxygen, carbon dioxide and water. This hot gas product, dependent on the ash content of the hydrocarbon feed is then subject to an optional solids removal step prior to its introduction into the partial combustion reactor where the oxygen contained therein supplies at least a portion of the oxidant requirement for partial oxidation and the carbon dioxide and water present therein are substantially converted to carbon monoxide and hydrogen. 3 claims, 2 figures.

PREPARATION

REFER ALSO TO CITATION(S) 31759

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 31846, 32196

32186 Apparatus for the production of cracked gas. Seelig, H.F.; von Waclawiczik, H. (to Fried. Krupp Gesellschaft mitbeschrankter Haftung). US Patent 3,923,466. 2 Dec 1975. Priority date 16 Dec 1971, German, Federal Republic of (F.R. Germany). 6p.

Cracked gas is produced by atomizing reaction materials consisting of carbon and/or hydrocarbon compounds with the assistance of superheated steam to form a mixture of superheated steam with finely dispersed particles of reaction materials. This mixture is fed into a reaction chamber where the superheated steam and the reaction material substantially react to form cracked gas. The produced cracked gas along with any remaining unreacted portion of the mixture is removed from the reaction chamber and passed through a heat exchanger in which the remaining mixture reacts so as to complete the production of the cracked gas. 8 claims, 4 figures.

32187 Producing gaseous fuels of high calorific value. Jones, J.K. (to Petrocarbon Developments Ltd.). US Patent 3,989,478. 2 Nov 1976. Priority date 27 Sep 1973, United Kingdom of Great Britain and Northern Ireland (UK). 12p.

Process for upgrading an air-contaminated methane composition such as is found near coal measures is described. It comprises condensing this gas, and thereafter fractionating it to yield a first product having a methane content higher than that of the initial composition and a calorific value commensurate with that of natural gas, and a second product having a methane content below that of the initial composition but above the highest limit of the flammability range for methane-air mixtures under the conditions of temperature and pressure prevailing in the process. 17 claims, 1 drawing figure.

32188 Method for producing gasoline from methanol. Daviduk, N.; Siuta, M.T. (to Mobil Oil Corp.). US Patent 3,998,899. 21 Dec 1976. Filed date 6 Aug 1975. 14p.

A method for converting lower alcohols to ethers and hydrocarbons in an exothermic restricted process control arrangement with efficient utilization of process generated heat is described. 8 claims, 1 drawing figure.

32189 Organic conversion system. Fleming, J. US Patent 4,002,438. 11 Jan 1977. Filed date 22 Jan 1975. 8p.

There is disclosed a method and an apparatus for converting organic materials into a high quality fuel product. The process involves introducing the organic materials into a stream heated to a temperature of about 1600°—2000°F and comprised of a carrier gas and a hard, particulate material. The organic material is rapidly converted into a fuel product which is then separated from the stream. The process can be used to form either a liquid or gaseous fuel product.

PREPARATION FROM WASTES OR BIOMASS

32190 (PB—259 292) Energy from municipal refuse: a waste utilization system for New York City. Schulz, H.W.; Benziger, J.B.; Hertzberg, R.H.; Szostak, R.M. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 15 Aug 1975. 123p. Q 06/MF/A01.

The objective of this research project is to design a pollution-free system for the economic utilization of municipal solid waste with emphasis on the conditions and requirements of New York City. In Phase I of this study a critical assessment was made of the leading advanced technology systems in terms of engineering estimates of capital requirements, operating costs, and by-product credits to select the process of greatest ecological and economic merit for the New York metropolitan area. Phase II of the Project addressed the larger question of designing a fully integrated waste utilization system for New York City, including the sizing and siting of the optimum mix of refuse conversion plants, and the disposition of the recovered energy and materials. The conclusions of this study and the recommended design, termed the Columbia Plan, are presented in this report. (GRA)

32191 (PB—259 956) Clean fuels from agricultural and forestry wastes. Final report Jun 74—Mar 75. Tatom, J.W.; Colcord, A.R.; Knight, J.A.; Elston, L.W. (Georgia Inst. of Tech., Atlanta (USA). Engineering Experiment Station). Apr 1976. Contract EPA-68-02-1485. 118p. Q 06/MF/A01.

The report gives results of an experimental investigation of the operating parameters for a mobile waste conversion system based on the Georgia Tech Engineering Experiment Station's partial oxidation pyrolysis process. The object of the testing was to determine the combination of parameters producing the most char and oil and the least gas from agricultural and forestry wastes. The test indicated both the dominant influence of air/feed on char and oil yields, and the desirability of low values of this ratio. In addition to the testing, a preliminary design of a 200 ton/day mobile pyrolysis system for conversion of agricultural and forestry wastes into clean fuels was made and a simplified economic analysis conducted. The results of this work indicate the technical feasibility and the economic profitability of such a system. (GRA)

32192 Anaerobic fermentation of poultry manure. Adderley, A.E.; Smith, I.E.; Probert, S.D. (Cranfield Inst. of Tech., Eng.). *Appl. Energy;* 2: No. 3, 163-173(Jul 1976).

Although both in nature and in conventional anaerobic decomposition process plants, acidification and gas production occur simultaneously, the rates of methane production and waste stabilization can be enhanced by arranging that the process occurs in two stages. Initially, the waste is fermented at an optimal temperature of 25°C and a 2.5%, by weight, total solids dilution to organic acids, and is subsequently transferred to a tank and held at optimal conditions for the methane producing bacteria.

32193 Decomposition of carbohydrate wastes. Appell, H.R.; Pantages, P. (to Energy Research and Development Administration). US Patent 3,989,480. 2 Nov 1976. Filed date 25 Mar 1976. 4p.

PAT-APPL-670,479.

Carbohydrate waste materials are decomposed to form a gaseous fuel product by contacting them with a transition metal catalyst at elevated temperature substantially in the absence of water. 8 claims, no drawings.

32194 Conversion of waste rubber to fuel and other useful products. Larsen, J.W. (to Tennessee Valley Authority). US Patent 3,996,022. 7 Dec 1976. Filed date 31 Jan 1975. 12p.

Heretofore waste rubber, a substantial amount of it in the form of used automobile tires, has been buried, burned, or otherwise

disposed of in manners and by means totally inconsistent with good ecological practices and considerations. Now, such waste or scrap rubber, both natural and synthetic, can readily be converted in the presence of molten acidic halide Lewis salt catalysts to useful products, including fuels comprising a naptha-like oil, a burnable solid carbonaceous material, and a mixture of gases. The most promising salts are zinc chloride, tin chloride, and antimony iodide. Also, an extremely active catalyst can be prepared by adding up to about 60 percent by weight of sodium chloride to the zinc chloride catalyst. The burnable carbonaceous material has been shown to be a carbon black of moderate quality and is believed to be suitable for reuse in tires if blended with high-quality fresh carbon black. 7 claims, no drawings.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 32798

PREPARATION

CHEMICAL SYNTHESIS

32195 Electrolytic synthesis of methanol from CO_2. Steinberg, M. (to Energy Research and Development Administration). US Patent 3,959,094. 25 May 1976. Filed date 13 Mar 1975. 4p.

PAT-APPL-558,188.

A method and system for synthesizing methanol from the CO_2 in air using electric power is claimed. The CO_2 is absorbed by a solution of KOH to form K_2CO_3 which is electrolyzed to produce methanol, a liquid hydrocarbon fuel. 2 claims, 1 figure.

32196 Concurrent production of methanol and synthetic natural gas. Cahn, R.P.; Longwell, J.P.; Wythe, S.L. (to Exxon Research and Engineering Co.). US Patent 3,993,457. 23 Nov 1976. Filed date 26 Nov 1975. 16p.

Methanol and synthetic natural gas are produced concurrently by introducing a carbonaceous material into a gasification zone, and thereafter, passing sequentially the synthesis gas thus formed through a water gas shift conversion zone, a sulfur compound and carbon dioxide removal zone, a methanol synthesis zone and a methanation zone. 21 Claims, 1 Drawing Figure.

PREPARATION FROM WASTES OR BIOMASS

32197 Method for producing synthetic fuels from solid waste. Antal, M.J. Jr. (to Energy Research and Development Administration). US Patent 3,993,458. 23 Nov 1976. Filed date 28 Mar 1975. 8p.

PAT-APPL-563,274.

Organic solid wastes represented by the general chemical formula C/sub x/H/sub Y/O/sub Z/ are reacted with steam at elevated temperatures to produce H_2 and CO_2 in an endothermic reaction. This heat is supplied by a tower top solar furnace; alternatively, some of the solid wastes can be burned to supply heat for the reaction. The hydrogen produced can be used as a fuel or a chemical feedstock. Alternatively, methanol can be produced by the commercial process. Since the reaction is endothermic, the system represents a method for storing heat energy from an external source in a chemical fuel produced from solid wastes. 6 Claims, 1 Drawing Figure.

PROPERTIES

32198 Promotion, by uranium(VI) oxide, of the iron catalysts for the synthesis of ammonia. Badik, V.S.; Lyubchenko, Yu.A. (Lvov Polytechnical Inst.). *J. Appl. Chem. USSR (Engl. Transl.);* **49**: No. 4, 910-912(Apr 1976).

Translated from Zh. Prikl. Khim.; 49: No. 4, 876-878(Apr 1976).

It has been shown for the case of iron catalysts for the synthesis of ammonia, of the precipitated type, that UO_3 is able to compete (as a promoter) with Al_2O_3. It has been found that the replacement of part of the Al_2O_3 in the catalysts by UO_3 leads to an increase in the activity, particularly for low temperatures (450 to 375°). The optimum composition of the catalyst containing three promoters has been determined, and found to correspond to the following concentrations of the promoters (mass %): UO_3 2, Al_2O_3 0.5, K_2O 0.4 to 0.6%. The calculated reaction rate constants (related to unit total surface area or to unit mass) confirm the advantage of the joint promotion of the catalysts with uranium and aluminum oxides.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 32190

32199 Metals in the wastes we burn. Campbell, W.J. (Bureau of Mines, College Park, MD). *Environ. Sci. Technol.;* **10**: No. 5, 436-439(May 1976).

The combustible fraction of municipal solid waste (MSW) is an important fuel supplement for meeting part of our national energy needs. This ongoing characterization program of MSW conducted by the Bureau of Mines is providing some of the essential data required to evaluate the possible environmental impact of using refuse-derived fuels. Studies to date show that several elements of environmental concern are found in significantly higher concentration in MSW than in coals; however, these elements could be significantly reduced in concentration if the public, through legislation, and industry decided that the present levels of these elements in combustibles are of concern and should be reduced. It should also be emphasized that as a low-sulfur fuel, MSW has advantages that should be considered relative to any possible adverse effect from trace elements in refuse-derived fuels.

32200 Agglomerated fuel from paddy husk by high pressure briquetting. Mitra, S.K.; Gupta, S.; Sengupta, A.K.; Mitra, S.R.; Chakravarti, A.K. (Central Fuel Research Inst., Dhanbad, India). *J. Inst. Eng. (India), Chem. Eng. Div.;* **56**: No. 3, 114-116(Jun 1976).

At present in India about 3 million tonnes of paddy husk is produced annually which has a very limited use. Briquettes can be produced from paddy husk by adopting high pressure technique without using any binder. These briquettes can withstand normal handling and transportation, and contain high percentage of volatiles and low fixed carbon. They cannot be efficiently burnt in conventional 'chullas' as they emit considerable smoke during burning as a result of incomplete combustion of volatile matters. Attempts to render these briquettes smokeless by devolatilization does not solve the problem as the recovery of carbonized product becomes too low and the product is not strong enough for normal handling. Moreover, the major portion of potential heat is lost by the escape of volatile matters during the process. It is, therefore, worthwhile to explore the possibilities of improving the combustion characteristics of raw briquettes through modifications of appliance and the mode of operation. The paper deals with the studies made at the Central Fuel Research Institute, Dhanbad, on the preparation of agglomerated fuel from paddy husk suitable for domestic use and also on the development of an efficient burning appliance for the agglomerated product.

HYDRO ENERGY

RESOURCES AND AVAILABILITY

32201 Austria's hydroelectric power potential, 1975. Partl, R.; Knauer, K. (Oesterr Elektrizitaetswirtsch, Vienna, Austria). *Oesterr. Z. Elektrizitaetswirtsch.;* **28**: No. 5, 317-323(May 1975). (In German).

The survey on Austria's developable hydro potential, which was published in 1970, is brought up to date allowing for the present situation of the power industry. Under the changed circumstances 45,600 GWh, instead of a former 43,050 GWh, may now be considered worth utilizing. The report gives a breakdown of this total according to capacity in operation and total potential as well as run of river and storage energy, and according to individual river basins and provinces.

SITE GEOLOGY AND METEOROLOGY

32202 (PB—256 729-T/SL) Hydrological field investigations for designing hydroelectric powerplants. Gotlib, Ya.L.; Kuzmin, I.A.; Razzorenov, F.F.; Sokolnikov, N.M. (Bureau of Reclamation, Washington, D.C. (USA)). 1976. Trans. of mono. Naturnye Gidrologicheskie Issledovaniya pri Proektirovanii GES, Leningrad, 1971. Sponsored in part by National Science Foundation, Washington, D.C. Special Foreign Currency Science Information Program. (TT—74-52003). 310p. NTIS (US Sales Only) $9.75.

The problems of full-scale hydrological field investigations made in the course of designing, construction and operation of hydroelectric power stations are discussed. Studies of flow hydraulics, river channel flow processes, thermal and icebound conditions are considered. The experience gained by the 'Hydroproject' Institute during full-scale field investigations is also discussed.

SOLAR ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 32255

32203 **Parameterization of solar absorption by nitrogen dioxide.** Luther, F.M. (Univ. of California, Livermore). *J. Appl. Meteorol.;* **15**: No. 5, 479-481(May 1976).

An analytic expression for the specific heating rate due to solar absorption by nitrogen dioxide is derived by approximating the solar insolation and absorption cross section by simple functions of wavelength. The analytic expression agrees with a detailed calculation to within +-2 x 10^{-22} W throughout the range of NO_2 column densities investigated (up to 10^{20} cm^{-2}). The error is within +- 0.3 percent for NO_2 column densities less than 2 x 10^{17} cm^{-2}. The error is generally within +- 5 percent for the larger column densities which rarely, if ever, occur in the atmosphere.

SOLAR ENERGY CONVERSION

32204 (PB—255703) **Photochemical conversion of solar energy. Quarterly progress report 1 Jan—31 Mar 1976.** Lichtin, N.N. (Boston Univ., Mass. (USA). Dept. of Chemistry). 28 May 1976. 26p. (NSF/RANN/SE/AER—72-03579/A05/76/1). NTIS (US Sales Only).

Prepared in cooperation with Exxon Research and Engineering Co., Linden, N.J. Continuation of Grant NSF-GI-38103. See also report dated 31 Jul 1975, PB—246156.

Ohmic resistance of the SnO^2 electrode of the iron-thionine (TH+) TI-TL SnO^2/Pt cell was shown to contribute to current losses. V(oc) of the cell varied linearly with log (white light intensity) up to at least 60 mW/sq cm while I(sc) varied linearly with light intensity up to approximately 30 mW/sq cm. Thin TiO^2 layers reduced with H^2 at 500C provide a promising selective anode for the iron-TH(+) cell. Cd^2SnO^4 deposited on quartz is a promising transparent cathode. Tuluidine blue O shows photogalvanic activity comparable to that of TH(+). Substantial sensitization to the blue of the photogalvanic activity of TH(+), methylene blue and azure A have been demonstrated for a number of dyes, of which Rhodamine 6G is the most effective sensitizer. Power output in white light has been increased by as much as 5.8 fold by sensitization. The dependence of the composition and kinetics of decay of the photostationary state of acidic iron-TH(+) solutions on solvent anions and initial concentrations of solutes has been measured and correlated with rates of elementary reactions.

32205 **Exploitation of solar energy.** Sobel'man, I.I. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *Sov. Phys. - Usp. (Engl. Transl.);* **19**: No. 9, 758-764(Sep 1976).

The problem of transformng the energy of solar radiation into heat and electricity is reviewed. The main attention is devoted to the possibility of heating up to fairly high temperatures, ~500degreeC, at which modern heat engines, turbines, etc., ensure efficient transformation of heat into electricity. Schemes are examined which are based on the use of comparatively simple concentrators of solar radiation and selective collectors. It is shown that, in addition to selective coatings, selective gas collectors are of great interest. The possibility of constructing large solar power stations is considered. At the end of the review, approximate estimates are given of the possible cost of a solar power station and the prospects for increasing the competitiveness of solar energy are discussed.

PHOTOVOLTAIC CONVERSION

32206 (AD—A031893) **Examination of laser-produced pressure pulses in a gallium arsenide solar cell. Master's thesis.** Jacobson, J.F. (Naval Postgraduate School, Monterey, Calif. (USA)). Jun 1976. 124p. Q 06/MF/A0150110B;97N.

Pressure pulses caused by irradiation of a model gallium arsenide solar cell with a carbon dioxide TEA laser were examined using power densities of the order of 10^7 power watts/sq cm. The pressure pulses were monitored with a Sandia type quartz pressure gauge. It was discovered that the relatively low power densities used were capable of removing the silicon dioxide antireflective and gold contact layers of the solar cell after only a few shots of the laser. An exponential relationship between the initial thicknesses of these layers and the pressure pulse generated in the gallium arsenide substrate was indicated for gold contact layers of less than 5000 A thickness. Evidence was found that the principal pressure generation mechanism is thermo-mechanical. Gold films of thickness greater than 5000 A were found to be able to absorb the power densities used with no apparent damage.

32207 (CONF-760837—P2, pp 676-696) **Deposition of gallium arsenide by liquid phase epitaxial growth of oxide substrate materials.** Stevenson, D.A.; Elliot, A.G.; Mattes, B.L. (Stanford Univ., CA). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of this program is to deposit gallium arsenide (GaAs) thin films on inexpensive substrate materials by liquid phase epitaxial (LPE) growth techniques for solar cell applications. The motivation for this work is based on the thickness of GaAs required for solar energy photovoltaic conversion (approximately 1 μm), the availability and cost of Ga and the expense of GaAs single crystals. The major aspects of this program include: a study of nucleation and growth of GaAs thin films by the LPE growth process on oxide substrates, the selection of suitable substrates and their preparation, the structural and elemental characterization of substrate surfaces and epitaxial films, and the analysis of the film's electrical properties. The program goals can be divided into three phases: (I) fundamental studies of nucleation and growth on single crystal oxide substrates; (II) growth on low cost substrates, particularly fused quartz; and (III) optimization of the growth process and thin films for solar cell device studies. The key results and future plans are presented.

32208 (CONF-760837—P2, pp 697-710) **Polycrystalline thin film gallium arsenide solar cells.** Borrego, J.M.; Ghandhi, S.K. (Rensselaer Polytechnic Inst., Troy, NY). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of this program is to investigate a new approach to photovoltaic energy conversion, based on the use of thin films of III-V compound semiconductors. The initial effort will be conducted on single crystal layers of GaAs for the purpose of developing the device physics; however, polycrystalline layers will be used in the final cell structures. A highly conductive transparent layer of degenerate tin-oxide will be evaluated as the upper contact for this structure. This program of materials and device development will be conducted simultaneously with one of device characterization. This is a newly-initiated program. Program plans are discussed.

32209 (CONF-760837—P2, pp 711-726) **Thin films of GaAs on low cost substrates.** Dapkus, P.D. (Rockwell International, Anaheim, CA). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

A program to apply the metalorganic chemical vapor deposition technique (MO-CVD) to the growth of thin films of GaAs and GaAlAs on low cost substrates being pursued at Rockwell ERD Division is discussed. The objective of this program is to develop deposition techniques on selected low cost substrates and improve the properties of these films so that heterojunction thin film solar cells with AM1 efficiency of 10 percent can be fabricated. Five main areas of investigation have been identified and are being pursued to achieve these goals. They are: (1) selection, evaluation and development of substrate materials, (2) development of the CVD process for these substrates, (3) evaluation of the properties of these films, (4) fabrication and evaluation of experimental devices, and (5) analysis and projection of cell fabrication costs.

32210 (CONF-760837—P2, pp 727-737) **Thin films of gallium arsenide on low-cost substrates.** Chu, S.S. (Southern Methodist Univ., Dallas). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of this program is to conduct intensive studies concerning thin films of gallium arsenide on low cost substrates as an initial step for the fabrication of low cost solar cells of relatively high efficiency. The areas of studies are: (1) the selection and the preparation of low cost substrates, (2) the deposition of gallium arsenide films on the substrates, (3) the characterization of the gallium arsenide films, (4) the control of conductivity type and carrier concentration in gallium arsenide films, and (5) the preparation, characterization, and optimization of gallium arsenide p-n junctions and solar cells. The program plan is outlined.

32211 (CONF-760837—P2, pp 738-758) **Silicon Schottky photovoltaic diodes for solar energy conversion.** Anderson, W.A. (Rutgers—the State Univ., New Brunswick, NJ). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

Schottky barrier solar cells (SBSC) on [100], p-type silicon are fabricated by thermal evaporation with an Al ohmic contact and 40—50 A Cr Schottky metal. A 10—20 A oxide between Si and Cr makes this a MIS device in which tunneling occurs through the oxide. Current research is directed towards achieving a 12 percent efficiency on 2-6 cm^2 cells by increasing fill factor from 0.65 to 0.75 and short circuit current density from 22 mA/cm^2 and 28 mA/cm^2. Results are presented.

32212 (CONF-760837—P2, pp 759-780) **Heterojunction solar cells.** Anderson, R.L. (Syracuse Univ., NY). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of this research is to investigate the material systems which may be useful for the fabrication of low cost, efficient heterojunction solar cells. The active substrate of principal interest is Si, in both single crystalline and polycrystalline form. Because SnO_2/Si cells of 10 percent efficiency at AM1 have been fabricated, this system appears to hold promise, although degradation of the cells has been observed. Major objectives of this effort are to determine the maximum theoretical conversion efficiency of SnO_2/Si HJSC's and to determine if the key observed degradation is inherent to these cells or if it can be avoided. Key results are summarized.

32213 (CONF-760837—P2, pp 781-790) **Twelve percent efficient indium tin oxide on silicon heterostructure solar cells.** DuBow, J. (Colorado State Univ., Fort Collins). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

Even though oxide semiconductor on silicon (OSOS) solar cells began receiving serious attention only 2 years ago, two laboratories, Syracuse University and Colorado State University, have reported OSOS solar cells with greater than ten percent efficiency. The Syracuse cells consisted of tin oxides evaporated onto single crystal n-type silicon and the Colorado State cells consisted of indium-tin oxides sputter deposited onto single crystal p-type silicon. The major objective of this program is to fabricate, test and package 2 cm x 2 cm OSOS solar cells of at least 12 percent efficiency in a manner consistent with continuous, low cost manufacturing techniques. Another major objective will be to evaluate the films and solar cells made during this program through an extensive series of measurements to determine an accurate model of device performance. A third objective is to use this model to evaluate (fabrication cost)/(device performance) tradeoffs to optimize the cell fabrication from the viewpoint of near term practical viability as a photovoltaic energy source. Testing under temperature and bias stress will be made to estimate degradation mechanisms. A final objective will be to quantitatively estimate the cost/watt of producing 500 MW/yr of OSOS cells and the sensitivity of these costs to variations in fabrication techniques, materials costs, labor costs and economic conditions. Research progress is reported.

32214 (CONF-760837—P2, pp 791-798) **Heterostructure single crystal silicon photovoltaic solar cells (type A, semiconductor heterojunction silicon devices).** Shaw, R.F. (Exxon Research and Engineering Co., Linden, NJ). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The research project on fabrication of SnO_2/Si; solar cells and theory of solar cell performance and degradation with a view to improving efficiency and stability is briefly outlined. (WHK)

32215 (CONF-760837—P2, pp 799-811) **Plans for MIS silicon cells.** Szedon, J.R. (Westinghouse Research Labs., Pittsburgh); Fonash, S.J. 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The overall objective for this project is to assess the technical and commercial practicability for power generation of metal heterojunction silicon photovoltaic cells of the metal-insulator-semiconductor (MIS) variety. Three major tasks are planned to achieve this objective: (1) fabrication of standard and experimental cells, (2) evaluation of cell performance and relation of performance to theoretical models, and (3) exploration of optimized cell performance. Activities and future plans are summarized.

32216 (CONF-760837—P2, pp 812-838) **Cuprous oxide photovoltaic cells.** Trivich, D. (Wayne State Univ., Detroit). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective is to prepare low cost cuprous oxide photovoltaic cells of good efficiency. It is expected that these will be front wall cells using single crystal or coarsely polycrystalline Cu_2O with Schottky barriers or heterojunctions. The program plan, key results, and future plans are summarized.

32217 (CONF-760837—P2, pp 839-864) **Investigation of low cost solar cells based on Cu_2O.** Olsen, L.C.; Bohara, R.C.; Hampton, H.L. (Univ. of Washington, Richland). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

A program to investigate low cost solar cells based on Cu_2O is described. The objectives are to (1) improve thin film Cu/Cu_2O backwall cell I-V characteristics, (2) carry out collection efficiency analysis of backwall cells, (3) characterize Cu/Cu_2O barrier in backwall cells in more detail, and (4) initiate frontwall cell study involving Schottky barriers and heterojunctions on polycrystalline Cu_2O. (WHK)

32218 (CONF-760837—P2, pp 865-879) **Zn_3P_2 for solar cells: improved semiconductors for photovoltaic cells.** Warfield, G. (Univ. of Delaware, Newark). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The overall objective of this project is to evaluate Zn_3P_2 "as a promising inorganic semiconductor having potential for mass-produced, low-cost high efficiency photovoltaic solar cells". Research activities are summarized.

32219 (CONF-760837—P2, pp 880-889) **Improved semiconductors for photovoltaic solar cells: $CuInSe_2$.** Mickelsen, R.A. (Boeing Aerospace Co., Seattle). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of this 13-month research program is the investigation of $CuInSe_2$ thin films as an inorganic semiconductor material having considerable potential for mass produced, low cost, high efficiency photovoltaic solar cells. $CuInSe_2$ was selected for study because it is one of only four material systems which have demonstrated conversion efficiencies greater than 10 percent and its properties are consistent with a thin film solar cell array costing less than $300/KW. This particular program is viewed as the first phase of the necessary technical effort leading to the development of these low cost thin film arrays. The current program activities and key results are summarized.

32220 (CONF-760837—P2, pp 890-907) **Study of II-IV-V_2 chalcopyrite semiconductors for solar cell applications.** Littlejohn, M.A. (North Carolina State Univ., Raleigh); Hauser, J.R.; Benson, R.B.; Schreiner, A.F.; Harrison, R.W. 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The major objective of this program is to investigate the growth and characterization of the II-IV-V_2 ternary semiconductors as a class of materials having promising potential applications for photovoltaic solar cells. The intent behind this program is a search for semiconductors other than Si, CdS, CdS/CuS, GaAs, and InP as alternative materials for mass-produced, low cost, high efficiency solar cells. Research plans are outlined.

32221 (CONF-760837—P2, pp 908-920) **Thin-film photovoltaics.** Fan, J.C.C. (Massachusetts Inst. of Tech., Lexington). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The ultimate objective of our thin-film photovoltaic program is the development of low-cost, efficient, thin-film solar cells. To prepare large-grain films for prototype solar cells, we will use laser crystallization, chemical vapor deposition (CVD), and vacuum deposition. We will then develop methods for fabricating solar cells from the films we prepare, placing particular emphasis on alternative techniques for junction formation, including indiffusion of dopants, ion implantation, multi-layer growth, and preparation of Schottky barriers. The application of transparent conductors such as Sn-doped In_2O_3 will also be investigated. Although some preliminary work is underway on CVD and vacuum deposition methods, the major emphasis so far has been on the crystallization of thin films of Si and GaAs by irradiation with a Nd:YAG laser.

32222 (CONF-760837—P2, pp 921-932) **InP/CdS thin film growth by planar reactive deposition for terrestrial solar cells.** Zanio, K.; Fraas, L. (Hughes Research Labs., Malibu, CA). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

An all thin film InP/CdS terrestrial solar cell is proposed. A thin film configuration is now possible as a result of the successful epitaxial deposition of thin films of InP on single crystals of (0001)

CdS at temperature below 390°C by the planar reactive deposition (PRD) technique and the formation of large (20 to 40 μm) single crystals of CdS through recrystallization. The PRD technique is a new thin film technique which offers the advantages of the chemical vapor deposition and molecular beam techniques but is not restricted by their limitations. In this technique indium metal is evaporated from a planar source in the presence of P_2 to form InP. The P_2 is available from the decomposition of phosphine introduced into the indium source chamber. Besides being a low temperature technique this process is scalable and is inherently clean because of the presence of H_2. The CdS films are thermally evaporated and undergo recrystallization in a post-evaporative H_2S heat treatment at about 450°C. They have been formed on soda-lime glass overcoated with indium-tin-oxide. This InP on CdS approach offers a quasi-single crystal all thin film solar cell with an active InP material crystallite width to thickness ratio of better than ten to one. Assuming 10 percent cell efficiency and 500 MW/year production capacity it is projected that cell costs based upon this thin film approach will be on the order of $250 per peak kW, which is attractive for large-scale utility applications.

32223 (CONF-760837—P2, pp 933-944) **Thin polycrystalline films of indium phosphide on low-cost substrates.** Ruth, R.P.; Dapkus, P.D.; Simpson, W.I.; Bube, R.H. (Rockwell International, Anaheim, CA). 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

A program has been proposed for the development of methods for making thin-film polycrystalline indium phosphide (InP) photovoltaic cells on inexpensive substrates. A cooperative effort is involved. The Rockwell Electronics Research Division will apply the metal-organic-hydride chemical vapor deposition (MO-CVD) method to the formation of InP films first on single-crystal and subsequently on low-cost polycrystalline or amorphous substrates, and the Stanford University Department of Materials Science and Engineering, as subcontractor, will deposit cadmium sulfide (CdS) and/or similar semiconductor compounds and alloys on the InP films to form heterojunction device structures. These will then be evaluated for their photovoltaic properties. The overall objective is to conduct fundamental studies which may lead to a low-cost, high-efficiency, long-life photovoltaic solar cell using a polycrystalline film of InP. The program plan is described.

32224 (CONF-760837—P2, pp 945-956) **Cadmium stannate selective optical films for solar energy applications.** Haacke, G. (American Cyanamid Co., Stamford, CT); Burton, L.C. 1976.

From 3. ERDA semi-annual photovoltaic program review; Orono, Maine, United States of America (USA) (3 Aug 1976). In Proceedings of the ERDA semiannual solar photovoltaic program review meeting.

The objective of the project is the development of low sheet resistance (approximately 1 ohm/square), transparent cadmium stannate coatings and the incorporation and testing of these electrodes in CdS (backwall) and silicon solar cells. The tasks also include the development of an economical spray deposition technique. During the past six months work was directed toward improving the economics of the spray deposition process and achieving a better optical quality of low-sheet resistance (less than 10 ohm/square), spray coated cadmium stannate films. In addition, conditions were optimized for the sputter deposition of cadmium stannate electrodes onto single crystal silicon substrates and work continued on the CdS backwall solar cell. Key results are summarized.

32225 (ERDA/JPL/954465—76/3) **Silicon sheet growth by the inverted Stepanov technique. Quarterly report No. 3.** Kim, K.M.; Cullen, G.W.; Berkman, S.; Bell, A.E. (RCA Labs., Princeton, N.J. (USA)). Dec 1976. Contract NAS-7-100-954465. 33p. (PRRL—76-CR-58). Dep. NTIS $4.00.

Efforts were continued to overcome the instabilities experienced when silica dies are used for growth of silicon ribbon in the inverted Stepanov configuration. These instabilities are associated primarily with the formation and evolution of the silicon monoxide; the escape of the gas causes hysteresis of the contact angle and mechanical vibration of the melt. As a result of this, the meniscus during the ribbon growth is not "pinned" at the die edge, but is in constant motion. The V-shaped susceptor has been modified to decrease the vertical gradient inside the susceptor in order to minimize the SiO formation and the related hysteresis. A pressure differential has also been applied across the melt in an effort to suppress the hysteresis. Various types of thermal trimmers have been tried to provide suitable thermal gradients at the solid-liquid ribbon growth interface. So far, the instabilities have not been suppressed sufficiently to allow for stable ribbon growth. The thermal stress exerted on the ribbon during growth can be reduced by minimizing the curvature in the ribbon temperature profile. (WDM)

32226 (ERDA/JPL/954471—76/2) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report Nos. 2 and 3, May 1, 1976—October 31, 1976.** Kapur, V.K.; Nanis, L. (Stanford Research Inst., Menlo Park, Calif. (USA)). Nov 1976. Contract NAS-7-100-954471. 25p. (ERDA/JPL/954471—76/3). Dep. NTIS $3.50.

Silicon can be produced by the reduction of SiF_4 gas with sodium in a reaction that initiates at temperatures lower than 175°C. The kinetics of the reaction can be affected by varying the partial pressure of SiF_4 gas. Emission spectrographic analysis of product silicon shows the major impurity to be sodium; but the metallic impurities that are known to degrade solar cell efficiency, such as Ti, V, Zr, and Cr, were not detected and must be less than 10 ppM.

32227 (ERDA/JPL/954521—76/2) **Integral glass encapsulation for solar arrays. Quarterly progress report No.2.** Kirkpatrick, A.R.; Kreisman, W.S.; Minnucci, J.A.; Younger, P.R. (Simulation Physics, Inc., Burlington, Mass. (USA)). Nov 1976. Contract NAS-7-100-954521. 38p. Dep. NTIS $4.00.

This is the second quarterly report under a fourteen month program to develop integral glass encapsulation for solar cell arrays. The report describes the status of development to establish techniques for employing electrostatic bonding in conjunction with terrestrial solar cells.

32228 (PB—259 195) **Photovoltaic II-VI compound heterojunctions for solar energy conversion. Doctoral thesis.** Buch, F. (Stanford Univ., Calif. (USA). Dept. of Materials Science and Engineering). Jun 1976. 167p. (NSF/RANN/SE/AER—75-1679/76). Q 08/MF/A01.

See also Quarterly report dated Apr 76, PB—254637.

In this investigation the authors have used the Close-Spaced Vapor Transport (CSVT) method to deposit semiconductor films onto single crystal (XL) substrates, thus preparing five II-VI heterojunctions: n-CdSe/p-ZnTe, n-CdTe/p-ZnTe, n-ZnSe/p-CdTe, n-CdSe/p-CdTe and p-ZnTe/n-ZnSe. Several cells of each type were made and tested, and it was found that the current transport mechanism is thermal activation and tunnelling into the heterointerface, where recombination takes place. This type of interfacial transport is mathematically formulated considering only the current controlling side of the interface, i.e. essentially the side having the largest potential barrier into the heterointerface. To describe the current-voltage behavior in light, a collection function that represents the bias voltage dependence of the collection of photogenerated carriers, was introduced. From the collection function the cell diffusion potentials have been determined, and using the film and substrate carrier densities, the electron affinities for CdSe (4.58 eV) and ZnTe (3.73 eV) were calculated relative to the electron affinity of CdTe, measured by Swank to be 4.28 eV. Knowing the electron affinities, band diagrams for the heterojunctions have been constructed.

32229 **Some comments on the evaluation of electrical parameters of a solar cell.** Murthy, B.S.; Tiku, P.; Sharma, N.K. (Solid State Physics Lab., Delhi). *J. Inst. Electron. Telecommun. Eng.;* **21**: No. 7, 359-363(Jul 1975).

The results of an evaluation of solar cells are presented. The parameters considered are short-circuit current, open circuit voltage, series resistance, forward diode characteristic "n" value, junction reverse current, and junction width. The advantage of the evaluation procedure over the method used by Mandelkorn et al., is pointed out.

32230 **Solar photopiles with n-CdS-p-CdTe heterojunctions.** Martinuzzi, M. (Faculty of Science and Technology, Marseille). *Phys. Status Solidi;* **34**: No. 1, K21-K26(16 Mar 1976).

The results of a series of experiments showed that this type of photovoltaic junction is capable of an effective collection coefficient of unity over almost the whole pass-band for a solar pile. An extension of this band to short wavelengths is possible with the ternary Cd/sub 1-x/Zn/sub x/S with x less than 0.3. With optimal dopage, using an antireflection layer and enlargement of the pass-band, the efficiency of such a pile should reach 8 to 10 percent. But the stability of these structures, apparently connected with displacement of the Cd in the CdS (where it is always found in excess), is still not satisfactory.

32231 **Low temperature proton irradiation damages in silicon solar-cells.** Nashiyama, I.; Teranishi, E.; Kageyama, M. (Electrotechnical Lab., Tanashi, Japan). *Jpn. J. Appl. Phys.;* **15**: No. 5, 945-946(May 1976).

Damages in N on P silicon solar-cells induced by proton irradiations at -103 +- 2°C are compared with damages of room temperature (18 +- 3°C) irradiations. A relative damage constant, which is proportional to damage constant but independent of proton energy, is introduced by the help of a theoretical model. Irradiation temperature dependences are discussed in terms of the relative damage constant.

SOLAR THERMAL POWER PLANTS

TOWER FOCUS POWER PLANTS

32232 (COO—2864-1) **Technical and economic feasibility of solar augmentation for boiler feedwater heating in steam-electric power plants.** (Franklin Inst. Research Labs., Philadelphia, Pa. (USA)). Nov 1976. Contract EY-76-C-02-2864. 94p. (F—C4362). Dep. NTIS $5.00.

This report presents the results of a five-month study on the technical and economic feasibility of augmenting the heating of boiler feedwater in steam-electric power plants by solar energy. The study was confined to investigating the possibility of retrofitting existing oil- or gas-fired steam plants with solar collection systems available now or in the near future. The use of four representative solar collectors was investigated in connection with different methods of single degree of freedom sun-following motions. For all collectors, daily sun-following without seasonal adjustment of tilt was found to be cost-effective. Solar augmentation of boiler feedwater heating does not constitute a cost-effective method of fossil fuel conservation. Under the most favorable conditions, an investment of $1200 or more is required to save one barrel of oil per year. Even if all potentially suitable power plants were equipped with solar augmentation, the resultant saving in oil and gas represents less than one-quarter of one percent of the current U.S. consumption of these fuels. A national survey of fossil fuel-fired steam-electric plants was conducted as a part of this study, and summary data are presented for each state.

32233 (SAN/1111—76-4) **Central receiver solar thermal power system. Collector subsystem annual technical progress report.** (Boeing Engineering and Construction, Seattle, Wash. (USA).). 14 Nov 1976. Contract EY-76-C-03-1111. 45p. Dep. NTIS $4.00.

In the Boeing collector subsystem concept, operating with a central receiver installation, circular membrane reflectors formed with aluminized polyester film, direct sunlight to the central receiver. Transparent air-supported plastic enclosures protect the lightweight reflectors from the environment. Reflectors are individually aimed with a 2-axis gimbal, driven by digital-controlled stepper motors. Minicomputers, at various locations in the heliostat field, provide signals to the stepper motors. Additional details of the collector subsystem design for both the Pilot Plant preliminary design (PD) baseline and research experiments is given. As part of this effort, three heliostats and a drive and control assembly are being fabricated and tested to provide design data and verification of the PD. In addition, an extensive evaluation program is being conducted on the key plastic materials used in the protective enclosure and reflector. Performance tests on large-scale heliostats are being conducted at a desert test site in northeast Oregon. Items completed during the past quarter include: fabrication of protective enclosures (domes) and reflectors; installation and initiation of environmental testing of two domes at Boardman, Oregon; and a major portion of assembly/integration tests on the collector subsystem, including domes, reflectors and the drive and control assembly. (WDM)

OCEAN THERMAL GRADIENT POWER PLANTS

32234 (COO/2581—3) **Marine pastures: a by-product of large (100 megawatt or larger) floating ocean-thermal power plants. Final report.** Laurence, S.; Roels, O.A. (Columbia Univ., Palisades, N.Y. (USA). Lamont-Doherty Geological Observatory). 31 Aug 1976. Contract EY-76-S-02-2581. 225p. Dep. NTIS $7.75.

The potential biological productivity of an open-sea mariculture system utilizing the deep-sea water discharged from an ocean-thermal energy conversion (OTEC) plant was investigated. In a series of land-based studies, surface water was used to inoculate deep water and the primary production of the resultant blooms was investigated. Each cubic meter of deep water can produce approximately 2.34 g of phytoplankton protein, and that an OTEC plant discharging deep water at a rate of 4.5×10^4 m^3 min^{-1} could produce 5.3×10^7 kg of phytoplankton protein per 350-day year. A series of land-based shellfish studies indicated that, when fed at a constant rate of 1.83×10^{-3} g of protein per second per 70-140 g of whole wet weight, the clam, Tapes japonica, could convert the phytoplankton protein-nitrogen into shellfish meat protein-nitrogen with an efficiency of about 33 per cent. Total potential wet meat weight production from an OTEC plant pumping 4.5×10^4 m^3 min^{-1} is approximately 4.14×10^8 kg for a 350-day year. Various factors affecting the feasibility of open-sea mariculture are discussed. It is recommended that future work concentrate on a technical and economic analysis. (WDM)

32235 (DSE/1005—1) **Geophysical fluid dynamics background for ocean thermal power plants.** Piacsek, S.A.; Toomre, J.; Roberts, G.O. (Naval Research Lab., Washington, D.C. (USA); Science Applications, Inc., La Jolla, Calif. (USA)). 1976. Contract E(49-26)-1005. 67p. (NRL-GFD/OTEC—11-75). Dep. NTIS $4.50.

The vertical temperature gradient in the tropical oceans can be used to operate ocean thermal power plants (OTPP's) that function as heat engines. Such energy extraction would entail very large scale pumping of both warm surface water and cold bottom water through heat exchangers, with consequent disturbance and extensive mixing of surface and deep waters. The temperature difference between the warm and cold inflow water should be maximized for plant efficiency, but entrainment and recirculation between the inflow and the outflow may reduce this temperature contrast. Further, horizontal currents and turbulence carry the outflow water to large distances and may produce significant changes. These flows are crucial in determining the thermal resource availability and the environmental impact of OTPP operation. This report provides background material and brief assessments in several areas of geophysical fluid dynamics (GFD) that bear directly on these problems. Relevant GFD research areas discussed include: turbulence and thermal wakes; ocean circulation and the permanent thermocline; air—sea interaction and thermocline variation; weather and climate modeling; and marine ecosystems. The report illustrates how each GFD area relates to specific OTPP problems, and emphasizes the multiple disciplines in GFD that must be considered.

32236 (DSE/1005—2) **Recirculation and thermocline perturbations from ocean thermal power plants.** Piacsek, S.A.; Martin, P.J.; Toomre, J.; Roberts, G.O. (Naval Research Lab., Washington, D.C. (USA); Science Applications, Inc., La Jolla, Calif. (USA)). 1976. Contract E(49-26)-1005. 26p. (NRL-GFD/OTEC—2-76). Dep. NTIS $4.00.

Numerical experiments were performed on the fluid motions resulting from the pumping action of ocean thermal power plants. In particular, the resulting thermocline distortions, sea surface temperature decrease, and corresponding heat flow change were investigated. The object was to find engine discharge configurations and pumping rates that would minimize these alterations. This would result in both a minimal environmental impact and preservation of the temperature gradient across the engine, i.e. the energy resource. The results obtained to date use 2-D turbulent flow calculations. Near the engine, the sea surface temperature reduction ranges from 0.01°F to 3°F, depending on design, flow rate, season, and location. The mean temperature of the warm inflow water is reduced by up to 4°F from the mean temperature at that depth, for certain designs and flow rates, due to recirculation and turbulence. The far-field surface heat calculations applied to the Puerto Rico area show that a depression of the sea surface temperature by 0.1°C leads to an increased heat flow from air to sea of 9.6 cal/cm^2/day, serving to replenish the heat removed from the surface layers by the plant. Accepting 0.1°C as a permissible environmental perturbation, the areal requirement for a typical 100 MW plant is 2500 km^2, with a radius of 28 km. The corresponding estimates for Hawaii are 4 cal/cm^2/day, an area of 6000 km^2, and a radius of 44 km.

32237 (DSE/1005—3) **Numerical ocean model of the Gulf of Mexico for evaluation of the environmental impact of ocean thermal power plants.** Thompson, J.D.; Hurlburt, H.E.; Lin, L.B. (JAYCOR, Del Mar, Calif. (USA); Naval Research Lab., Washington, D.C. (USA)). 1976. Contract E(49-26)-1005. 42p. (NRL-GFD/OTEC—3-76). Dep. NTIS $4.00.

Studies of OTPP effects on the far-field thermal gradient resource require a knowledge of the dynamics and thermodynamics of the time-dependent ocean. Short of actual OTPP operations, one can only assess the impact of OTPP's on the environment via long-term integrations of numerical ocean models. The best strategy for OTPP far-field modeling appears to be the selection of a single, well-observed ocean basin with well defined boundary conditions and surface input data. Conditions within the basin should be as representative as those to be encountered by OTPP's in the tropical and subtropical oceans. The basin should be large enough to represent open ocean conditions but small enough for economical computer modelling. It is suggested that the Gulf of Mexico satisfies the above requirements for OTPP evaluation. Further, it is believed that a numerical model superior to previous Gulf of Mexico models in (1) resolution, (2) physical processes included, and (3) numerical efficiency can be developed to a level useful for OTPP environmental impact studies. The ocean model must reproduce observed features of the actual ocean before it is useful for assessment of OTPP environmental modification. A strategy for development of a hierarchy of models is presented, and basic requirements for a useful ocean model are outlined.

32238 (DSE/1005—4) **Comparison of three diffusion models of the upper mixed layer of the ocean.** Martin, P.J. (Naval Research Lab., Washington, D.C. (USA)). 1976. Contract E(49-26)-1005. 56p. (NRL-GFD/OTEC—4-76). Dep. NTIS $4.50.

The Munk—Anderson, Vager—Zilitinkevich, and Mellor—Yamada turbulent diffusion models were used to model the upper mixed layer of the ocean and were compared to determine differences in predicted mixed layer depths for simple cases of mixed layer

deepening. The mixed layer depths predicted by the models were found to be very strongly dependent upon the value of the Richardson number above which the generation of turbulence by the mean velocity shear was stabilized by the stratification. The larger this critical value of the Richardson number, the further the mixed layer deepened before the stratification at the base of the mixed layer was able to suppress the turbulent mixing and stop further erosion of the thermocline.

32239 (DSE/1005—7) **Two-dimensional numerical model of the near-field flow for an ocean thermal power plant. Part III. Manual for the computer code NRFL02.** Roberts, G.O.; Piacsek, S.A.; Toomre, J. (Science Applications, Inc., La Jolla, Calif. (USA); Naval Research Lab., Washington, D.C. (USA)). 1976. Contract E(49-26)-1005. 52p. (NRL-GFD/OTEC—7-76). Dep. NTIS $4.50.

This report is a user's manual for the computer code NRFL 02 which has been developed to calculate the near-field stratified turbulent flow driven by the intakes and outflows of an ocean thermal power plant. The code uses a two-dimensional geometry and a four-parameter first-order turbulence closure model. Sophisticated numerical methods enable convergent and accurate solutions to be obtained rapidly and economically. A large and feasible printer output package provides for the display and interpretation of the results.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 32197

SPACE HEATING AND AIR CONDITIONING

32240 (DSE/2322—1(Suppl.)) **Economic analysis of solar water and space heating.** (Mitre Corp., McLean, Va. (USA). METREK Div.). Nov 1976. Contract EX-76-C-01-2322. 312p. Dep. NTIS $9.75.

Based on comparison with conventional energy costs, solar water heating and solar space heating installed at an equivalent system cost of $20 per square foot of collector is competitive today against electric resistance systems throughout most of the U.S. If the system cost is reduced to $15 per square foot, solar systems become competitive against oil hot water heating and/or oil and electric heat pump space heating in many cities. Finally, if the cost should be reduced to $10/ft^2 by 1980 through a combination of technical innovations and incentives, solar hot water and heat would be economically competitive against all residential fuel types. Solar system designs for 13 cities were optimized so as to minimize the life cycle cost over the assumed 20 year life time of the solar energy systems. The major assumptions regarding the solar system, type and use of buildings, financial considerations, and economic environment used in the design optimization are given. This supplement contains raw data and is included in the base report DSE/2322-1 in the form of conclusions. (WDM)

32241 (NBSIR—76-1137) **Thermal data requirements and performance evaluation procedures for the national solar heating and cooling demonstration program.** Streed, E.; McCabe, M.; Waksman, D.; Hebrank, J.; Richtmyer, T. (National Bureau of Standards, Washington, D.C. (USA). Inst. for Applied Technology). Aug 1976. Contract E(49-1)-3800. 86p. Dep. NTIS $5.00.

The purpose of this document is to provide the rationale and description of the data requirements, instrumentation types and data analysis methods used to monitor and evaluate the field demonstration systems. It is recognized that complete instrumentation and subsequent technical evaluation of each system/building/climate combination cannot be perfomed because of the cost and data analysis limitations. Therefore, only selected unique installations will be completely instrumented and as the exact design and location of all sites becomes available, optional measurements will be made to evaluate significant features. (WDM)

32242 (TID—21337) **Executive summary of the National Solar Energy workshop of the ERDA Division of Solar Energy and the state energy offices.** Christensen, D.L.; Stuhlinger, E. (Alabama Univ., Huntsville (USA). Center for Environmental and Energy Studies). Jul 1976. Contract E(49-18)-2409. 25p. Dep. NTIS $3.50.

This report summarizes the activities and results of the National Solar Energy Workshop held in Huntsville, Alabama, on May 19 through 21, 1976. The workshop was sponsored for the express purpose of providing a forum for state participatory planning in solar-energy programs having national implications. Each of the states was invited to attend and 30 states, Puerto Rico and Canada, were represented at the workshop. The workshop was organized and structured to place emphasis on solar radiation collection and solar heating and cooling programs. It also formulated the Federal and State governmental interactions deemed necessary to meet National goals.

32243 **Environment assisted hydronic heat pump system.** Meckler, M. US Patent 3,996,759. 14 Dec 1976. Filed date 3 Nov 1975. 12p.

An air conditioning system is described utilizing one or more water source heat pumps assisted by solar radiation, terrestrial reradiation and ambient air above predetermined temperature levels; operating primarily in cooperation with a stratified thermal mass in the form of a hot liquid storage tank that is compartmented according to the operational temperatures of high range closed circuit solar energy accumulation, moderate range closed circuit heat pump requirements and low range auxiliary needs, the collection of solar heat being applied to all ranges whereby temperature differential is maximized for solar collection; and operating secondarily in cooperation with a thermal mass in the form of a cold liquid storage tank charged through a cooler means and/or assisted by terrestrial reradiation and used to provide supplementary cooling capacity for the heat pump when required, whereby the operational water temperature range of the heat pump is maintained for effective functioning of the system.

32244 **Solar heated buildings: a brief survey. 13th and final edition.** Shurcliff, W.A. Cambridge, MA; William A. Shurcliff (1977). 331p. (NP—21690).

Concise, factual descriptions are presented of the great majority of solar-heated buildings (319). All types of buildings are included: houses, apartment buildings, office buildings, factories, banks, schools, etc. Completed buildings are included, and also buildings that are under construction or have been planned in detail and are to be under construction soon. (WDM)

32245 **Operational modes of solar heating and cooling systems.** Ward, D.S.; Smith, C.C.; Ward, J.C. (Colorado State Univ., Fort Collins). *Sol. Energy;* **19**: No. 1, 55-61(1977).

This paper emphasizes factors associated with the subsystems that are required to extract heat from solar collectors, store this heat, and deliver it to the loads upon demand. While minimum use of auxiliary energy is the general objective, it must be sought with due regard to safety, convenience and cost. Subsystem alterations that improve energy efficiency typically come at added cost in terms of installation and maintenance. In some cases, the advantages of a specified component or arrangement of components are immediately evident. In other cases, such options are less decisive and will require longer periods of comparative operation to arrive at accurate assessments. The Colorado State University Solar House I allows for such comparative operation in several experimental modes. These selected modes of operation provide for different methods of solar heat transfer and employ different arrangements of system components and control functions. The principles underlying these modes as well as results of these studies are presented. In addition, the methods of operation found necessary for efficient and reliable performance are discussed. While this evaluation is an ongoing process, the initial "start up" and "break in" periods have been experienced and serve as a basis for several recommendations concerning subsystem components and component arrangements.

32246 **Design of a solar heating and cooling system for CSU Solar House II.** Ward, D.S. (Colorado State Univ., Fort Collins); Loef, G.O.G.; Smith, C.C.; Shaw, L.L. *Sol. Energy;* **19**: No. 1, 79-85(1977).

This paper describes the design of a solar air heating and night/day exchange cooling system with emphasis on the operational modes. In this type of system the collector absorbs solar energy and converts it to heat for space heating and domestic water heating. Cooling is accomplished by using the cool night air available in dry climates to cool a pebble-bed storage unit and subsequently using the cool pebbles to lower the air temperature in the building during the day. Circulation is from the solar system to the building in the same manner as most modern heating and air conditioning units but uses air as the medium for heat transfer. The air system is particularly suited for climatic regions where heating loads are high and cooling requirements are moderate. The system utilized in Solar House II operates in either the heating or cooling mode as selected through a seasonable change-over switch. Solar preheated hot water is furnished for domestic use in either mode.

WATER HEATING

REFER ALSO TO CITATION(S) 32240, 32241

32247 **Solar water heating system.** Harrison, H. (to Halm Instrument Co., Inc.). US Patent 3,989,032. 2 Nov 1976. Filed date 8 Dec 1975. 2p.

A system for solar heating of water in combination with a domestic hot water system having a hot water storage tank having an inlet and an outlet, and a controllable heater arranged for heating water for storage within said storage tank. A solar heat collector has a surface which absorbs sunlight to produce heat, and a heat exchange passage for water in heat conductive relation. Piping and

pump means are provided for circulating water from said tank outlet through said collector heat exchange passage to said tank inlet. An inflatable elastic member extends substantially the entire length of said collector passage. Means are provided to maintain air within said inflatable member at a higher hydrostatic air pressure than the static hydrostatic water pressure in said passage whereby the collector is rendered tolerant to freezing.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 32205

32248 (ANL-SOL—77-01) **Status report for nonimaging collectors (compound parabolic concentrators), July 1976—January 1977.** Schertz, W.W.; Winston, R.; Matlock, R.G. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 52p. Dep. NTIS $4.50.

The history of the development of the compound parabolic concentrator is reviewed. Current activities for the period July 1976-Jan. 1977 are summarized in detail. Possible applications of the CPC are briefly discussed. (WDM)

32249 (PB—258848) **The evaluation of surface geometry modification to improve the directional selectivity of solar energy collectors. Final report, 1 Dec 1973—31 Dec 1975.** Howell, J.R.; Bannerot, R.B. (Houston Univ., Tex. (USA). Dept. of Mechanical Engineering). 31 May 1976. 125p. (UHME/Sol—11). NTIS, PC A06/MF A01.

See also report dated 31 Jan 1975, PB—244376. Continuation of Grant NSF-GI-41003.

This report examines the radiative performance of directionally selective collectors composed of parallel, east-west oriented, stationary, trapezoidal grooves. Computer simulations for their radiative performance were developed. Experimental models of the collector geometry were constructed and tested. The radiative performance of these models was compared to that predicted, with good agreement achieved, verifying the computer simulations. Computer simulations of radiative behavior with direct beam, non-direct, and various combinations of insolation are presented.

32250 (SAND—76-0425) **Solar Collection Module Test Facility, instrumentation fluid loop number one.** Harrison, T.D.; Dworzak, W.R.; Folkner, C.A. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract E(29-1)-789. 40p. Dep. NTIS $4.00.

This document provides information needed to establish the interface between Fluid Loop No. 1 of Sandia Laboratories' Solar Collector Module Test Facility and an item to be tested on the loop. While data on mechanical, electrical, instrumentation, and fluid loops are not sufficient to enable complete planning for every possible test, they are judged adequate to enable initiation and completion of interface specifications with a minimum of additional data and effort. Fluid Loop No. 1 is designed to evaluate collectors and components of collectors using Therminol 66 as a heat transfer fluid. Fluid Loop No. 1 will deliver heat transfer fluid to the test item at temperatures from 20°C to 315°C (70°F to 600°F) at flow rates from 0.1 gpm to 10.0 gpm at pressures up to 0.51 MPa (75 psig). Fluid Loop No. 1 has a weather station and an HP 2116 minicomputer which is capable of directing the test, acquiring data, and performing calculations.

32251 **Solar heat collector.** Thomason, H.E.; Thomason, H.J.L. US Patent 3,989,031. 2 Nov 1976. Filed date 29 Oct 1974. 4p.

Open-flow solar heat collectors have been used since 1959 in Thomason Solar House No. 1, similar to those disclosed in U.S. Pat. Nos. 3,145,707 and 3,215,134. Improvements were needed to avoid heat loss, vapor loss, and condensation, near the top and bottom of the corrugated solar heat collector sheet. In the present invention a transition area or transition section is used to change the collector sheet from its irregular or non-planar configuration to a substantially planar configuration. At the bottom, the irregular, non-planar sheet may be formed to a planar configuration and then shaped to form a collector trough with an outlet for warm water flowing therefrom. At the top, the irregular, non-planar collector sheet may be changed, at the transition area or section, to a substantially planar configuration and substantially sealed to, or adjacent to, the collector glazing material to reduce heat and vapor loss at the top.

32252 **Solar energy absorber plate having a breather tube.** Bauer, W.R.; Schutrum, L.F. (to PPG Industries, Inc.). US Patent 3,989,536. 28 Dec 1976. Filed date 19 Mar 1975. 16p.

A solar heat collector has a breather tube provided on the absorber plate to provide communication between the ambient air and air in the airspace of the collector through desiccant material. In this manner, the air pressure in the airspace is equalized to the ambient air pressure without moisture moving into the airspace and the desiccant material is regenerated. 23 claims, 8 figures.

32253 **Solar-optical analyses of a mass-produced plastic circular fresnel lens.** Harmon, S. (Arizona State Univ., Tempe). *Sol. Energy;* **19**: No. 1, 105-108(1977).

Experiments were performed to gain information on the behavior of the 3M circular fresnel lens as a solar concentrator. A simulation was constructed to model that behavior. From consideration of the results of this work, it can be said that the lens is an inefficient concentrator with losses that begin at 20 and rise to about 80% as the focal distance decreases. However, the lens is capable and adequate for low concentration purposes with photovoltaic systems. The most attractive aspects of using this lens as a solar concentrator are its availability and its potential low cost.

HEAT STORAGE AND REJECTION

32254 (EPRI-EM—256-SY) **Advanced thermal energy storage (TES) systems. Interim summary report, research project 788-1.** (Boeing Engineering and Construction, Seattle, Wash. (USA).). Nov 1976. 35p. Dep. NTIS $4.00.

In December, 1974, EPRI initiated research for high temperature gas cooled central receivers for solar energy which included a contract (RP377-1) to Boeing Engineering and Construction (BEC) for receiver conceptual design of energy storage systems compatible with the higher temperature (816°C vs. 550°C) gas turbine systems. In February, 1976, an EPRI/ERDA program coordination was initiated to examine in greater detail the technical feasibility of high temperature thermal energy storage (TES). The two advanced systems are a phase change energy storage with inorganic salts and a reversible thermochemical reaction energy storage system. A third system, a sensible heat pebble bed energy storage system, was investigated as a near term benchmark. The phase change concept offers the most economic incentive primarily as a result of its high storage density. Major technical barriers involve storage media and container material compatibility testing. The thermo-chemical concept is the most attractive from a plant control flexibility standpoint. The major technical uncertainty is the required catalytic SO_3 dissociation reactor.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

32255 **Alternative energy sources.** Ruiter, J.P. *Elektrotechniek;* **53**: No. 4, 183-195(Mar 1975). (In Dutch).

The possibilities of some nonconventional energy sources such as solar radiation, tidal energy and geothermal energy are described. Also the sources derived from the solar radiation such as wind, temperature differences in the oceans and organic wastes are included in this survey.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

32256 (PB—257225) **Cooperative geochemical resource assessment of the Mesa Geothermal System. Final report.** Coplen, T.B. (California Univ., Riverside (USA). Inst. of Geophysics and Planetary Physics). Mar 1976. Contract DI-14-06-300-2479. 118p. (IGPP-UCR—76-1). NTIS (US Sales Only) $5.50.

In order to effectively develop this geothermal resource the Bureau of Reclamation began conducting a reservoir analysis study in 1972. As an aid to understanding the reservoir characteristics of this system, and in particular, the hydrology of the system, a geochemical study of samples of geothermal fluid, ground water, cores, and cuttings was initiated. The primary aim of this investigation was to obtain information about water rock interactions and about the hydrogeology of this system. In particular, data pertinent to the quantity of water flowing past each gram of sediment was obtained by using stable isotope studies of oxygen, carbon and hydrogen. (GRA)

32257 **Volcanic rocks of the eastern and northern parts of the San Francisco volcanic field, Arizona.** Moore, R.B.; Wolfe, E.W.; Ulrich, G.E. *J. Res. U.S. Geol. Surv.;* **4**: No. 5, 549-560(Jul 1976).

The eastern and northern parts of the San Francisco volcanic field, between San Francisco Mountain and the Little Colorado River, contain about 175 cinder cones, many with one or more associated lava flows, and one center of silicic volcanism, O'Leary Peak. Basaltic flows and cones are divided into five groups, primarily on the bases of stratigraphic and physiographic relations, degree of weathering and erosion, K-Ar and tree-ring age determinations, and, in part, chemical and petrographic data.

32258 Qualitative models of spreading-center processes, including hydrothermal penetration. Lister, C.R.B. (Univ. of Washington, Seattle). *Tectonophysics;* **37**: No. 1-3, 203-218(5 Jan 1977).

Observations on active geothermal areas suggest that water can penetrate rapidly into hot rock, and this is confirmed by semi-quantitative theory. Upwelling of magma material at an oceanic spreading center places hot rock close to an ample supply of cold water. Clues to the nature of the interaction can be found in the structure of ophiolite suites, and in simple physical induction on the nature of the upwelling. The subsurface dike injection zone seems to be dominated by conductive cooling and to provide a barrier against water penetration as long as it is heated by liquid magma in a chamber below. As soon as the magma has crystallized into a cumulate, water penetration proceeds rapidly to the base of the crust. It is probably stopped by meeting an ultramafic layer of olivine phenocrysts separated from the upwelling melt. The olivine crystals may be oriented by a fluidized-bed process near the spreading axis, forming a thin acoustically anisotropic layer. Below, mantle material depleted by partial melting grades back to primitive composition at depth. The mantle material should remain viscous enough to upwell in a broad zone, and the coupling of distributed upwelling to a thick rigid crust formed close to the spreading axis is responsible for the central valley and block tectonics characteristic of slow-spreading ridges. At fast spreading rates, the larger magma chamber decouples a thinner rigid surface layer and smooth topography results.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

32259 Evidence for fluid bodies beneath the Sulfur Springs geothermal region, St. Lucia, West Indies. Aspinall, W.P.; Michael, M.O.; Tomblin, J.F. (Univ. of the West Indies, St. Augustine, Trinidad). *Geophys. Res. Lett.;* **3**: No. 2, 87-90(Feb 1976).

During a 39-day microearthquake survey in the Sulphur Springs geothermal region, St. Lucia, seven local hypocenters were determined. Emergent P onsets and missing S-waves were observed for five of these, and attenuated S-waves recorded for two regional events. These imply the presence of at least two significant fluid bodies beneath the area. Ground noise measurements near natural steam vents suggest a deep source for the steam.

GEOCHEMICAL TECHNIQUES AND SURVEYS

32260 Nature and regularities of the distribution of helium and argon isotopes in thermal waters of the Kuril Islands and the Kamchatka. Gutsalo, L.K. (Inst. of Geology and Geochemistry of Fossil Fuels, Lvov). *Geokhimiya;* No. 6, 886-895(Jun 1976). (In Russian).

According to the isotopic composition, helium of thermal sources of the Kuril Islands and of Kamchatka is in the main a mixture of helium of the upper mantle with helium of the atmosphere. This is confirmed by the revealed single dependence between ^3He and ^4He concentrations in thermal waters and the atmospheric air dissolved in water. In the isotopic balance of argon of thermal waters, mainly argon of the atmosphere and of the upper mantle is presented. Regularities in the enrichment of thermal waters by mantle argon are established, whose supply is certainly accompanied by an addition of mantle helium. A direct dependence between the isotopic composition of helium ($^3He/^4He$) and argon ($^{40}Ar/^{36}Ar$) of apparently mantle origin has been revealed for the first time in gases of thermal sources. This dependence also reflects the process of isotopic mixing of helium and argon of the upper mantle with helium and argon of the atmosphere. Helium and argon migration from the upper mantle is accomplished mainly in the free phase. According to experimental data most probable values of isotopic ratios for helium and argon of the upper mantle of the region under investigation have been established.

32261 Comparative data on the volatile component composition of magma. Kravtsov, A.I.; Onikiyenko, S.K. *Int. Geol. Rev.;* **18**: No. 7, 766-772(Jul 1976).

The results of several hundred analyses of fumarole gases of the Kuril—Kamchatka area are classified and tabulated. Studies in the geology and geochemistry of natural gases associated with magmatism yielded much information on the composition of volcanic gases of this zone. Also fumarole gases directly correlated with eruptive or lava streams and gases of hot springs were studied. The main attention was centered on the geochemistry of carbon and hydrogen as the principal elements of the hydrocarbons in the earth's crust. (MHR)

32262 Isotopic composition of carbon of gases of active volcanoes and hot springs of the Kuril-Kamchatka volcanic arc. Kravtsov, A.I. *Int. Geol. Rev.;* **18**: No. 7, 773-786(Jul 1976).

To determine the effect of geologic factors on the composition of abyssal derivates (complementing existing information on the geochemistry of volcanic gases) isotopic analysis of carbon was used to obtain physicochemical criteria of the origin of gases, independent of geologic-petrographic data. The investigations include component analysis of all the gases, particularly hydrocarbon compounds, repeatedly found in the fumarole emanations of pyroclastic streams. Volcanic carbon dioxide which is the principal component of gases of active volcanoes and hot springs in the Kuril-Kamchatka volcanic arc and of other volcanoes was investigated.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 32748

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 32263

GEOTHERMAL POWER PLANTS

32263 (EPRI-ER—301) Energy conversion and economics for geothermal power generation at Heber, California, Valles Caldera, New Mexico, and Raft River, Idaho: case studies. Topical report 2. Holt, B.; Ghormley, E.L. (HOLT/PROCON, Pasadena, Calif. (USA)). Nov 1976. 124p. Dep. NTIS $5.50.

A portion of the results from a one-year study to assess the feasibility of constructing a 25 to 50 MWe geothermal power plant using low-salinity hydrothermal fluids as the energy source is presented. The objective of this report was to investigate the compatibility of the different power conversion options with real geothermal reservoirs and to analyze the economics of power generation. Nine cases are discussed which were chosen to yield further insight into the effect of reservoir temperature on the choice of conversion technology and power costs. These cases examine flashed steam, binary cycle and hybrid conversion for Raft River, Idaho; Heber, California; and Valles Caldera, New Mexico that have bottom-hole temperatures of approximately 150°C, 180°C and 260°C, respectively. Conceptual layouts of the power conversion processes, cycle analyses and economic analyses are presented. The principal conclusions are: a hydrothermal demonstration plant is technically environmentally, and economically feasible in the 1980 time frame; the recommended demonstration site is Heber, Imperial Valley, California; binary cycle power conversion technology is recommended; the recommended demonstration plant capacity is approximately 50 MWe; and there are no overriding environmental constraints.

GEOTHERMAL ENGINEERING

32264 Geothermal chemical engineering. Axtmann, R.C.; Peck, L.B. (Princeton Univ., NJ). *AIChE J.;* **22**: No. 5, 817-828(Sep 1976).

Most of the problems in geothermal chemical engineering fall into these categories: resource development and management, energy extraction and utilization, power cycle design and optimization, environmental engineering, and corrosion and scaling of equipment. Reinjection of waste fluids, insofar as it proves feasible, will affect the shape of the solutions in all categories. Convective hydrothermal reservoirs are immense, permeable media in which heat and mass transport are coupled with chemical reaction. No satisfactory physical or mathematical model exists for any reservoir. Even less is known about the hot rock and geopressured resources, which also may be utilized ultimately. Electric power production receives primary emphasis in the United States. Worldwide, however, the total power devoted to agricultural activities, space heating and cooling, and process heat applications is greater than that to electric power conversion. Much current development effort aims at power cycles that promise enhanced efficiencies and that avoid some of the problems of corrosion and scaling. Among the candidates are several binary cycles which employ secondary working fluids, and the total flow concept, wnich utilizes two-phase flow from the production wells. The environmental effects of geothermal installations have recently been subjected to informed scrutiny and found nonnegligible. Among the problemareas are gaseous effluents including hydrogen sulfide, mercury, radon, ammonia, and H_3BO_3 and aqueous emissions that contain heavy metals. Reinjection of waste geothermal fluids would ameliorate many environmental impacts but could be complicated by silica deposition in equipment and in the underground reservoir.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

32265 Downhole heat exchanger investigations. Culver, G. (Oregon Inst. of Tech., Klamath Falls). *Q. Bull., Geo-Heat Util. Cent.;* **2**: No. 2, 1(Oct 1976).

In order to obtain data on the long-used present downhole heat exchanger (DHE) design, temperature profiles were taken on nearly 20 wells with DHE's installed at no-load conditions. Vertical flow measurements were made on seven wells that did not have DHEs installed, some of which were cased and some uncased, using a spinner device. In one well there was the opportunity to measure temperatures and flow, install a DHE, and test the DHE before and after the perforated casing was installed. (MHR)

DIRECT ENERGY UTILIZATION

32266 Maywood industries of Oregon uses 118°F well for heating. Lienau, P.J. *Q. Bull., Geo-Heat Util. Cent.;* **2**: No. 2, 3(Oct 1976).

To maintain the millwork plant temperature at 60 to 65°F there is a 1500 ft deep well producing warm water at a temperature of 118°F, (lowest temperature well in Klamath area for direct use) with a 75 horsepower pump installed adjacent to the building. This will supply all the heating for the building through ten 378,000 BTU per hr air handling units and four 1,856,000 BTU per hr make-up air units. The average water flow for a winter day will be 150 gallons per minute, with a 535 gallon per minute maximum at full load. The geothermal heating used on an annual basis represents the equal of 70,600 gallons of oil. (MHR)

32267 Milk pasteurization with geothermal energy. Lund, J.W. *Q. Bull., Geo-Heat Util. Cent.;* **2**: No. 2, 4(Oct 1976).

Geothermal hot water has been used to pasteurize milk at Medo-Bel Creamery in Klamath Falls for over 30 years. Geothermal hot water is also used to heat the 30,000 square foot building. The pasteurization process involves pumping up to 50 gallons per minute into the building and through a short time pasteurizer. The geothermal water is pumped from the well at 189°F and passes through the heat exchanger where the milk is heated to a minimum temperature of 171°F for 15 seconds and then quickly chilled to 38°F to retain its flavor. A total of 500,000 pounds are processed each month. In addition some batch pasteurizing of ice cream mix is carried out by geothermal heat. The estimated savings amount to approximately $1000 per month. (MHR)

32268 Uses of geothermal energy in Rotorua, New Zealand. Lund, J.W. *Q. Bull., Geo-Heat Util. Cent.;* **2**: No. 2, 5(Oct 1976).

The hydrothermal activity of the Rotorua Geothermal field, the second most extensively exploited geothermal resource in New Zealand (after Wairakei), is described briefly. Steam and hot water from approximately 350 shallow wells has been used on a small scale to heat homes and buildings, domestic hot water supplies, steam cooking boxes, and swimming pools. Geothermal steam and hot water are also used in mineral bathing pools, for hot-house horticulture and soil sterilization, kiln drying of timber, and to drive a large hotel air conditioning refrigeration plant. Some detail is given on these uses. After use, the geothermal effluent is discharged down shallow soak holes. (MHR)

GEOTHERMAL DATA AND THEORY

PROPERTIES OF MINERALS AND ROCKS

32269 Optical properties and electronic structure of mantle silicates. Nitsan, U.; Shankland, T.J. (Harvard Univ., Cambridge, MA). *Geophys. J. R. Astron. Soc.;* **45**: 59-87(1975).

Unpolarized specular reflectance spectra at near-normal incidence were measured in the silicates olivine, pyroxene, spinel and Al-garnet in the photon energy range 4 to 14 eV at 300°K, and the optical and dielectric functions were obtained from the reflectance by Kramers—Kronig analysis. The spectra indicate that these minerals, with a variety of divalent cation substitutions, have wide valence and conduction bands separated by an energy gap (E/sub g/) of 7.5 to 9.5 eV that is marked by a prominent absorption peak of an exciton associated with this gap. E/sub g/ increases with the ratio x = Mg/(Mg+Fe+Mn+Ni+Ca) and in olivine it varies from 7.8 eV in fayalite to 8.8 eV in forsterite. For a given x, E/sub g/ increases in the order spinel, olivine, pyroxene, garnet over a range of about 1.5 eV. While the pure Mg-silicates are transparent at photon energies below the exciton peak, transition metal substitutions result in strong absorption beginning about 1 to 2 eV below E/sub g/, presumably due to electronic transitions between the wide bands and d states localized on the transition metal cations. The large magnitude of E/sub g/ rules out the possibility that electronic band conduction due to valence-conduction band excitations is an important conduction mechanism in mantle silicates.

ROCK-WATER-GAS INTERACTIONS

32270 Behavior of water and carbon dioxide during formation and gas release of acidic magmas. Kadik, A.A.; Eggler, D.Kh. (Inst. of Geochemistry and Analytical Chemistry, Moscow). *Geokhimiya;* No. 8, 1167-1175(Aug 1976). (In Russian).

Crystal—liquid—vapor equilibria in the join $NaAlSi_3O_8$—CO_2—H_2O have been investigated to pressures of 30 kbar. Based on these data significant fractionation of evolved vapor in terms of H_2O and CO_2 content during partial melting of the crust and ascending acidic magmas through the crust will lead to the continental crust zoned in volatile composition, the lower crust being CO_2—rich and the upper crust more H_2O—rich.

ISOTOPE AND TRACE ELEMENT STUDIES

32271 Carbon compounds in fluid inclusions of hydrothermal quartz. Naumov, G.B.; Mironova, O.F.; Naumov, V.B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). *Geokhimiya;* No. 8, 1243-1251(Aug 1976). (In Russian).

On the basis of microscopic observations and of the results of chemical analyses of fluid inclusions in quartz of various geneses, not only the broad participation of carbon dioxide was shown in them but of the more reduced varieties of carbon too. The possible errors of the method connected with the heat opening of the inclusions during the experiments were analyzed. The role of different forms of carbon as regulators of acidity and redox potentials of hydrothermal solutions was discussed.

TIDAL POWER

REFER ALSO TO CITATION(S) 32255

WIND ENERGY

32272 Closing energy gaps with the aid of wind power. Upmalis, A. *Energie;* **28**: No. 9, 262-265(Sep 1976). (In German).

7 figs.; 1 tab.; 5 refs.

The exhaustion of fossil and nuclear fuel reserves predicted is the starting point for considerations concerning the utilisation of the non-exhaustive wind power. The dependences of the efficiency of utilisation are sketched, and experimental wind power plants already in use with outputs of between 100 and 200 kW are described in some detail. At the same time planning, as well as current research into the utilisation of wind energy is taking place.

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 32255

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

32273 Application of laminated wooden blades to a two-meter Darrieus type vertical axis wind turbine. Butler, B.L. (Sandia Labs., Albuquerque, NM); Blackwell, B.F. *SAMPE Q.;* **8**: No. 2, 1-6(Jan 1977).

This paper describes the use of laminated Lauan plywood in a 2-meter-diameter, 3-bladed Darrieus wind turbine. The manufacture, testing and tensile stress analysis of laminated wooden blades are described. The 2-meter wind turbine model tests indicated that, with appropriate blade design, wood has potential for small vertical axis wind turbines.

32274 Materials and processing approaches to cost competitive wind turbine rotor blades. Rothman, E.A. (United Technologies Corp., South Windsor, CT); Deabler, H.E. *SAMPE Q.;* **8**: No. 2, 13-21(Jan 1977).

A study was made of materials and processes using metallics and composites or combination of both for the fabrication of low cost wind turbine blades. As a result of these studies the filament winding process was selected as offering the potential for low cost fabrication while requiring the minimum compromises in aerodynamic shape, optimum structure, and weight. The process is described which is compatible with existing winding facilities and equipment and which results in near optimum structural fiber orientation. Fiberglass material is used with a resin system appropriate for the process and requiring minimum curing time and equipment.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

32275 (EPRI-EL—367) **Long term power system dynamics: Phase II. Final report.** Schulz, R.P.; Turner, A.E. (General Electric Co., Schenectady, N.Y. (USA). Electric Utility Systems Engineering Dept.). Feb 1977. 287p. Dep. NTIS $9.25.

Results of Phase II research on long-term system dynamics are reported. Phase I, completed in 1974, undertook a survey of major power system disturbances occurring in the U.S. and in Europe that were caused by an imbalance between generation and load. This phenomenon, defined as long term-power system dynamics, is one factor in the propagation of major, widespread blackouts. Such disturbances have not been analyzed properly in the past because the industry lacked an accurate computer model to portray the long term system behavior. The purpose of Phase I was to develop a prototype computer model that could be used for study of efficient corrective measures that would lessen the impact of such system disturbances. In the Phase II effort, the systems analyzed were expanded in size, including models of such critical components as the boiling water reactor and the combustion turbine.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

32276 (FRNC-CONF—147) **Forced draft wet cooling systems.** Daubert, A.; Caudron, L.; Viollet, P.L. (Electricite de France, 75 - Paris). 1975. 10p. (In French). (CONF-7510143—15). INIS.

From Cycle of lectures on the cold sources of electric power plants; Royaumont, France (6 Oct 1975).

The disposal of the heat released from a 1000MW power plant needs a natural draft tower of about 130m of diameter at the base, and 170m height, or a cooling system with a draft forced by about forty vans, a hundred meters in diameter, and thirty meters height. The plumes from atmospheric cooling systems form, in terms of fluid mechanics, hot jets in a cross current. They consist in complex flows that must be finely investigated with experimental and computer means. The study, currently being performed at the National Hydraulics Laboratory, shows that as far as the length and height of visible plumes are concerned, the comparison is favorable to some types of forced draft cooling system, for low and medium velocities, (below 5 or 6m/s at 10m height. Beyond these velocities, the forced draft sends the plume up to smaller heights, but the plume is generally more dilute.

32277 (FRNC-CONF—153) **Drift deposition ("primage") and droplet separation in cooling systems.** Fesson, J.P. (Compagnie Electro-Mecanique (CEM), 75 - Paris (France)). 1975. 14p. (In French). (CONF-7510143—17). INIS.

From Cycle of lectures on the cold sources of electric power plants; Royaumont, France (6 Oct 1975).

Power plants are often cooled by means of wet cooling towers for recycling the cooling water in closed circuits. Nevertheless, a fraction of this water is drifted by the air draft circulating inside the tower and falls out onto the neighborhood such leading to fog or glazed frost formation in cold weather and to a permanent pollution. Studies performed till now show that the droplets result from water vapor condensation and water deposition drift ("primage"). Measurements effected at the neck of a natural draft tower in operation and with a test bench allowed to specify the water fraction drifted by 'primage' and establish the size spectrum of the droplets. Three complementary methods of measurement were used: laser beam diffraction, droplet trapping on a sensitized paper, and isokinetic sampling of the whole effluent. The following results were obtained: the 'primage' deposition drifted water is 0.0011 of the whole flow and the water drifted under the form of droplets with a size larger than 100μ is 0.00041 of the whole flow. Such results show that the consequences of ("primage") drift deposition on the environment are suppressed of minimized and its effects rended negligeable when suitable droplet separators are used.

POWER CYCLES

REFER ALSO TO CITATION(S) 32232

32278 **Combined gas turbine and steam power plant.** Aguet, W. (to Sulzer Brothers Ltd.). US Patent 3,992,876. 23 Nov 1976. Priority date 15 Jan 1974, Switzerland. 4p.

The plant has a combustion chamber which is connected to a thermal preparation plant for fuel in order to receive prepared fuel. The thermal preparation plant has a heat exchanger for condensing heavy sulphur-containing fractions of heavy oil. This heat exchanger is connected in parallel with the evaporator of the steam generator to receive the working medium for the production of steam at the same steam pressure as in the evaporator. A second fuel supply is connected to the combustion chamber to supply fuel when the preparation plant is shut down. A burner is also connected to the steam generator to heat the various heating surfaces for producing steam when the preparation plant is shut down.

WASTE-FUELED SYSTEMS

REFER ALSO TO CITATION(S) 32199, 32773, 32774

COMPONENTS

32279 (EPRI-FP—317) **Assessment of the feasibility of advanced steam power plant cycles utilizing atmospheric fluidized bed steam generation and heating, Task I. Final report.** Kight, S.W. Jr.; Rosard, D.D. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA); Westinghouse Electric Corp., Lester, Pa. (USA). Steam Turbine Div.). Dec 1976. 184p. Dep. NTIS $7.50.

In pulverized coal fired boilers, an upper limit to attainable steam temperature is imposed by the deposition of slagged ash and of corrosive material onto superheater tubes. This corrosive material derives from mineral impurities in the coal which, following heating from 2500 to 3000°F in the flame, form complex salts some of which are liquid above about 1200°F. In a fluidized bed the maximum temperature is about 1600°F, which is low enough to inhibit formation of corrodants and to prevent the melting of ash, so that these particular problems may be avoided. On this basis, it has been suggested that the fluidized bed boiler might open the way to more efficient steam cycles, using higher temperatures. This project was initiated to see whether there were other factors, particularly in the steam turbine, that would restrict the development of advanced steam plant using existing or near future technology. The study shows that the fabrication of very large high quality rotor forgings in "super alloys" suitable for high temperature service is the major obstacle. This, and other problems are discussed in detail. Steam temperatures to 1100°F could be attained using stainless steel superheater tubing and 1200°F with nickel based alloys. This steam admission temperature range could be utilized in a turbine with an alloy steel rotor provided that the first stage nozzle temperature drop ensured a rotor admission temperature of 1100°F. Such a first stage arrangement would be relatively inefficient. Above 1200°F the rotor would require a super alloy forging which at present could not be made for units above 450 MW.

32280 (FRNC-CONF—151) **Computations for a condenser. Experimental results.** Walden, J. (Compagnie Electro-Mecanique (CEM), 75 - Paris (France)). 1975. 23p. (In French). (CONF-7510143—19). INIS.

From Cycle of lectures on the cold sources of electric power plants; Royaumont, France (6 Oct 1975).

Computations for condensers are presented with experimental results. The computations are concerned with the steam flux at the condenser input, and inside the tube bundle. Experimental results are given for the flux inside the condenser sleeve and the flow passing through the tube bundle.

32281 **Thermal power plant.** Pacault, P.H. (to Fives-Cail Babcock). US Patent 3,992,884. 23 Nov 1976. Filed date 3 Jan 1975. 4p.

A portion of the steam produced in a nuclear power plant at relatively low pressure is substantially adiabatically compressed, and the compressed, heated steam is employed for superheating the steam supplied to one or both stages of a steam turbine which drives the generator. The energy gained by superheating may be greater than that spent in compressing a portion of the steam.

32282 **Mathematics and models aids turbine generator developments.** *Electr. Rev.;* **199**: No. 23, 58-59(10 Dec 1976).

Efforts to solve medium term problems in the design of turbine generators, including mathematical models and insulation studies, are discussed. A typical mathematical model is the three-dimensional magnetic model of the end region of a large generator. The model is used to investigate the effects of design changes such as rotor diameter and length, the use of magnetic or non-magnetic caps, and the effects of the positioning of the stator frame members. Epoxy resin bonded mica insulation has improved mechanical and electrical properties over natural resin bonded mica insulation. Insulation testing is described. (PMA)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 32678

32283 **Method for transportation and utilization of waste heat of large condenser power plants.** Adrian, F. (to Deutsche Babcock and Wilcox AG). US Patent 4,006,857. 8 Feb 1977. Priority date 21 Dec 1974, German, Federal Republic of (F.R. Germany). 4p.

A method is described for transporting heat over long distances in which waste heat from large power plants is utilized. The condenser back-pressure is increased to a level so that the condenser

cooling water acquires a temperature in the range of 25 to 50°C. The cooling water is subsequently pumped through large pipelines to heat consumer centers where it serves as a heat source for heat pumps. The heat content of the condenser cooling the water is used for raising the temperature of a heating medium to such a degree that the heat content can be used for heating purposes. After giving off the heat, the condenser cooling water may be used for cooking or drinking purposes, or for the dilution and cooling of waste water.

ECONOMICS

REFER ALSO TO CITATION(S) 32279, 32747

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 33268

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 31767, 31768, 33144

32284 (PB—259 211) **Control of waste and water pollution from power plant flue gas cleaning systems: first annual R and D report. Annual report Jan—Dec 75.** Leo, P.P.; Rossoff, J. (Aerospace Corp., Los Angeles, Calif. (USA)). Oct 1976. Contract EPA-68-02-1010. 176p. (ATR—76(7297-01)-2). Q 09/MF/A01.

The report given summarizes and assesses the state of research and development in the fields of non-regenerable flue gas cleaning (FGC) waste treatment, utilization, and disposal, as well as water reuse technology, for coal-fired utility power plants. Significant results cover: (1) chemical and physical characterization of wastes from eastern and western U.S. plants using lime, limestone, or double-alkali scrubbing systems; (2)chemical and physical properties and leaching characteristics of treated and untreated wastes; (3) field evaluations of treated and untreated waste disposal; (4) disposal alternatives; (5) cost estimates for ponding and for fixation disposal methods; (6) disposal standards; (7) gypsum production and marketing; (8) potential use of wastes in fertilizer production and portland cement manufacture; (9) beneficiation studies; and (10) total power plant water reuse.

32285 Electrostatic precipitator with rapper and pneumatic flow blocking. Ramsey, J.R.; Baier, T.D.; Swim, W.B. (to Trane Co.). US Patent 3,988,130. 26 Oct 1976. Filed date 24 Sep 1975. 10p.

An electrostatic precipitator is disclosed which is provided with a plurality of gas jets which upon activation repulses the normal gas flow through the electrostatic precipitator during cleaning to create a quiescent condition to reduce further dispersion of the loosened particulate layer into the outlet stream. A control system for operating the jets and the discharge and collector plate rappers is shown.

32286 Electric particle precipitator. Hogg, W.R. (to Coulter Electronics, Inc.). US Patent 3,988,128. 26 Oct 1976. Filed date 21 May 1974. 8p.

A method and apparatus are disclosed wherein an ac signal charges droplets sprayed into a chamber as the droplets are formed. The frequency of the ac signal is high enough so that the individual droplets are charged differently than their neighbors. The differently charged droplets create a nonuniform electric field within the chamber. The nonuniform electric field causes particles, entering the chamber in a fluid medium such as air, to be attracted to and attach to the droplets thereby precipitating out of the fluid medium.

32287 Electrostatic precipitator apparatus and method. Schumann, J.L. US Patent 3,988,127. 26 Oct 1976. Filed date 7 May 1975. 14p.

Each precipitation chamber of an electrostatic precipitator has an airlock provided by closable damper means and located in the path of the gas flow through the chamber between the inlet plenum and outlet plenum of the precipitator. Apparatus is provided in association with each airlock for establishing a gas pressure diferential between the airlock and the rest of the chamber so that essentially no uncleaned gas can pass by leakage through the airlock to the precipitator outlet. The airlock is established during normal precipitator cleaning (rapping), thereby enhancing the effectiveness of cleaning by stopping gas flow through the chamber during cleaning, increasing particulate fall into the hoppers and permitting optimization of rapping intensity, rate and frequency. Precipitator efficiency is increased significantly by preventing outflow of re-entrained particulates during cleaning.

32288 Process for recovering sulfur from fuel gases containing hydrogen sulfide, carbon dioxide, and carbonyl sulfide. Hill, E.S. (to Shell Oil Co.). US Patent 3,989,811. 2 Nov 1976. Filed date 10 Nov 1975. 6p.

Sour gas streams containing significant quantities of H_2S, CO_2, and COS are contacted with an aqueous absorbent to remove the acid gases. The acid gases are described and contacted with a selective absorbent which rejects a substantial quantity of the CO_2. The H_2S enriched absorbent is stripped to produce a feed suitable for Claus units.

32289 Hydrogen sulfide removal. Toyama, A.; Ishizaki, K. (to Kobe Steel Ltd.). US Patent 3,989,810. 2 Nov 1976. Priority date 16 Nov 1967, Japan. 14p.

A process is described for the removal and conversion into sulfur of hydrogen sulfide in a gaseous or liquid material. The material is treated with an oxidative lignin prepared by treating lignins with oxidizing agents, nitrating agents and/or demethylating agents and, if desired, introducing hydrophilic groups into the resultant product. The lignins include protolignin, isolated lignins and other denatured lignins. The process is advantageous essentially in that hydrogen sulfide can be removed economically and converted completely into sulfur, and that the desulfurization agents, i.e., the oxidative lignins, are nontoxic and non-corrosive.

32290 Regenerating flue gas desulfurization catalysts with reducing gas. Greene, D.F.; Lang, R.J.; Welty, A.B. Jr. (to Exxon Research and Engineering Co.). US Patent 3,989,798. 2 Nov 1976. Filed date 23 Jul 1973. 8p.

Flue gas is desulfurized by absorbing it onto a selective absorbent-catalytic material. The absorbed SO_2 is recovered by contacting it in a desorption cycle with a reducing desorption gas. In one embodiment, multiple absorbent beds are employed and alternate absorption-desorption cycles are used in each of the multiple beds with the flue gas and the desorption gas used alternately. The sulfur oxide is recovered in concentrated form in the desorption gas stream and is then utilized as feed in a conventional sulfuric acid plant yielding concentrated sulfuric acid.

32291 Process for removing sulfur oxides from gas streams. Brady, J.D.; Legatski, L.K. (to FMC Corp.). US Patent 3,989,797. 2 Nov 1976. Filed date 15 Mar 1974. 18p.

In a system for removing sulfur oxides from flue gas, the gas is contacted by a primary extraction solution containing sodium sulfite as the active compound and some sodium bisulfite in a scrubber, and the resultant extract containing more sodium bisulfite is mixed with an alkaline solution containing regenerated sodium sulfite in a mixer to produce the primary extraction solution. A portion of the latter is bled off to a regenerator wherein the quantity of sodium bisulfite made in the scrubber reacts with calcium hydroxide to form regenerated sodium sulfite and large diameter calcium sulfite precipitates that remain suspended in the parent solution. This mixture is drawn off the regenerator by overflow, without pumping, for gravity flow to the eye of a thickener, wherein an increased density slurry of the mixture is withdrawn from the thickener well and directed to a rotary filter to produce a calcium sulfite filter cake. The resultant filtrate and the solids free overflow from the thickener provide the sodium sulfite solution inputs to a holding tank, from which the liquor is pumped through a back washed polishing filter and back to the mixer. Flyash, initially present in the incoming flue gas, is separated from the gas in the scrubber and passes through the system to the filter, where it acts as a filter-aid.

32292 Method for removing sulfur dioxide in the form of calcium sulfite from combustion exhaust gas. Morita, T.; Funahashi, I.; Igarashi, K.; Takaiwa, M. (to Kureha Kagaku Kogyo Kabushiki Kaisha). US Patent 3,989,796. 2 Nov 1976. Priority date 19 Sep 1972, Japan. 8p.

A method is described in which sulfur dioxide contained in combustion exhaust gas is absorbed in an aqueous alkali sulfite solution to produce a corresponding alkali bisulfite and the resultant aqueous alkali bisulfite solution is added with calcium carbonate to form calcium sulfite. The method consists of wet-powdering the calcium carbonate into a particle size within a range of 0.1 to 30 μ in a slurry form by the use of a part of a filtrate which is obtained by separating calcium sulfite from the reaction solution, and reusing the remainder of the filtrate as an aqueous alkali sulfite solution for absorbing sulfur dioxide, whereby substantially no waste water is discharged out of the reaction system and sulfur dioxide can be recovered in the form of highly pure calcium sulfite.

32293 Selective removal of nitrogen oxides from waste gas. Morikawa, K.; Nishida, F.; Yamada, T.; Suzuki, N.; Takeda, T.; Yanagihara, T.; Adach, K.; Asanabe, T.; Ohsato, K.; Tsuda, K. (to Japan Gasoline Co., Ltd.). US Patent 3,993,731. 23 Nov 1976. Priority date 10 Jun 1974, Japan. 6p.

A process is described for the removal of nitrogen oxides from a waste gas containing said oxides in conjunction with sulfur oxides which comprises contacting said waste gas with ammonia as a reducing agent at temperatures of from 250° to 550°C in the presence of a catalyst wherein an active component containing iron or copper as the active metal and a sulfate of aluminum are supported on a silica carrier.

32294 Scrubber and combustion apparatus. Lowery, L. Sr. US Patent 3,993,448. 23 Nov 1976. Filed date 29 Apr 1975. 8p.

A pollution control unit comprises a tank having an outlet and an inlet for gases treated therein. A pair of spray compartments are spacedly situated within the tank, and a de-entrainment compartment is situated between the spray compartments. A series of spaced baffles define the spray and de-entrainment compartments and in addition define the flow path of the gases serially through the compartments. Spray devices are provided for directing water sprays into the gases but only within the spray compartments.

32295 Removal and recovery of sulfur dioxide from stack gases. Duvall, L.J. US Patent 3,994,706. 30 Nov 1976. Filed date 12 Feb 1975. 6p.

A method and apparatus for the removal and recovery of sulfur dioxide from gaseous effluent is disclosed. Sulfur dioxide entrained in stack gases, emanated upon combustion of sulfur-bearing materials, is selectively liquefied under the combined influence of a reduction in temperature and an increase in pressure of the gaseous effluent.

32296 Method of removing fly ash particulates from flue gases in a closed-loop wet scrubbing system. Melin, D.D. Jr.; Grieve, D.F. (to Krebs Engineers). US Patent 4,000,991. 4 Jan 1977. Filed date 5 Dec 1975. 12p.

A method of removing flyash particulates suspended in industrial waste gases generated from the combustion of fossil fuels in a totally enclosed scrubbing liquor circuit whereby an inert diluent such as Na_2SO_4 is used for inhibiting the dissolution rates of the alkaline earth, silica, and clay mineral ingredients in the ash when the collected particulates are intermixed and suspended in weak acid solutions produced in the wet scrubbing process. The diluent may be added to the system or, if the waste gas contains significant amounts of sulfur oxides, it may be formed in situ.

32297 Process for the desulfurization of flue gas. Longo, J.M. (to Exxon Research and Engineering Co.). US Patent 4,001,375. 4 Jan 1977. Filed date 21 Aug 1974. 6p.

A process for the removal of sulfur oxides from gases is described that is comprised of the steps of contacting the gas with a cerium oxide sorbent at conditions whereby the sulfur oxides present in the gas are sorbed by the cerium oxide sorbent and regenerate the cerium oxide sorbent by contacting it with a reducing atmosphere at conditions whereby the sorbent is substantially converted to a sulfur-free state. The gas may be an exhaust gas, e.g., from an automobile or a flue gas. This invention is especially preferred for treating flue gas. In this preferred embodiment, the flue gas may be contacted with the cerium oxide sorbent at a temperature of from 300° to 800°C, to form cerium sulfate and/or sulfite and the sorbent is regenerated by contacting with a reducing gas, for example, hydrogen in admixture with steam or other inert gases at a temperature of from 500° to 800°C to convert the cerium sulfate or sulfite to cerium oxide. During the regeneration step, the desorbed species is initially sulfur dioxide. However, when about 50% of the sulfur is removed from the sorbent, the desorbed species becomes H_2S. Thus, the instant invention provides SO_2 and H_2S in admixture with the excess reducing gas, which can be fed conveniently to the Claus plant for conversion into elemental sulfur.

32298 Flue gas desulfurization sorbent and process. Cull, N.L.; Smith, W.M. (to Exxon Research and Engineering Co.). US Patent 4,001,376. 4 Jan 1977. Filed date 6 Mar 1975. 14p.

Sulfur dioxide is removed from gas mixtures such as flue gas containing the same by contacting the gas mixture with a solid sorbent comprising a porous gamma-alumina base, about 2 to 20% by weight (based on alumina) of a coating of a refractory oxide such as titanium dioxide, zirconium dioxide, or silica, and an active material, such as copper oxide, which is capable of selective removal of sulfur oxides from a gas mixture.

32299 Sulfur dioxide collection. McKie, R.T. US Patent 4,002,724. 11 Jan 1977. Filed date 21 Nov 1975. 8p.

Flue gas that includes sulfur dioxide and alkali-containing flyash is cleansed in a liquid scrubber, followed by classification of discharge from the liquid scrubber into oversize and undersize fractions. The undersize fraction is clarified and recycled for use as a source of liquid scrubbing agent. The oversize scrubber discharge is reduced in particle size to expose more alkali-reactive surface and recycled into the scrubber for further reaction with SO_2.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 32275

32300 Correlation between the dissipation factor and partial discharges in liquid nitrogen impregnated layer insulation. Juchniewicz, J.; Pospieszna, J. (Technical Univ., Wroclaw). pp 524-525 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Dissipation factor of model liquid nitrogen impregnated layer insulation was measured in various measuring conditions. The partial discharges occurring in the tested samples were registered simultaneously. The results show very close correlation between the dissipation factor and the intensity of partial discharges. The partial discharges seem to be mainly responsible for the rise to tan delta with electrical stress.

32301 Internally cooled high-voltage high-energy cable. Rasquin, W.; Suetterlin, K. (to Felten and Guilleaume Kabelwerke AG). US Patent 3,988,526. 26 Oct 1976. Priority date 5 Apr 1973, German, Federal Republic of (F.R. Germany). 8p.

A cable for transmitting high electric energies comprises an inner tubular member which is provided with a channel for conducting a cooling medium, cable jacket surrounding the tubular member with spacing, and insulation provided intermediate said tubular member and cable jacket. The tubular member is circumferentially complete so that no cooling medium can escape into the insulation and destroy the insulating properties thereof. The tubular member may itself serve as an electric conductor, or it may be surrounded by an electric conductor.

AC SYSTEMS, EHV AND UHV

32302 (EPRI—7817-1) High ampacity potheads. Final report. Nicholas, J.H.; Selsing, J. (G and W Electric Specialty Co., Blue Island, Ill. (USA)). Oct 1975. Contract E(49-18)-1562;EPRI-RP-7817-1. 129p. Dep. NTIS $6.00.

Three different designs of 230 kV high ampacity potheads were evaluated to determine: how the ampacity ratings can be increased by forced circulation of cooled or refrigerated oil; the influence of 3 different types of low-viscosity oils on the thermal characteristics of the 3 pothead designs; effect of the 3 oils on pothead materials and vice versa; and projected performance of the potheads at ratings between 69 kV and 500 kV based on extrapolated data. Details of the pothead designs, testing facilities and procedures, and results are presented. (LCL)

32303 (EPRI-EL—228) Analysis of forced cooling of compressed gas insulated transmission lines. Final report. Cookson, A.H.; Lapen, R.J.; Kothmann, R.E. (Westinghouse Electric Corp., Westborough, Mass. (USA). CGIT Lab.). Dec 1976. 107p. Dep. NTIS $5.50.

A thermal and cost analysis of forced cooling of buried, compressed gas insulated transmission lines (CGIT) was made. Only direct cooling of the sheath is considered, with water coolant flowing in aluminum pipes integrally extruded or directly bonded to the CGIT aluminum sheath. Both isolated phase and three conductor CGIT systems are considered with maximum voltage rating from 145 to 1200 kV. The lines are the designs and sizes based on present practice of self cooled systems. The CGIT lines have aluminum conductors and sheaths, and are filled with SF_6 at a pressure of 50 psig. The thermal analysis shows that cooling the sheath is an efficient technique of forced cooling CGIT lines, relying on the efficient thermal processes in the SF_6 inside the line to convey the heat from the conductor to the sheath. For a maximum sheath temperature of 60°C, the current rating can be doubled for all voltage ratings without exceeding the maximum conductor temperature of 100°C. Still higher current ratings are possible with reduced maximum sheath temperature at an increase in cooling system costs. The total system costs of installing buried, forced cooled CGIT lines are calculated for the isolated phase and three conductor CGIT lines for 145 kV to 1200 kV at the various current ratings. The total installed cost, including forced cooling and present worth of losses, is lower for the three conductor system by 10 percent to 15 percent at voltage up to 362 kV, and 5 percent lower at 550 kV. At higher voltages the three conductor system will be too large to be practicable.

32304 Transient thermal performance of a LNG-cooled power transmission line. O'Farrell, P.M. (Arthur D. Little Inc., Cambridge, MA); Cravalho, E.G.; Toscano, W.M. pp 518-523 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

An earlier work evaluated the steady-state thermal performance of a total energy transmission system which used subcooled liquefied natural gas (LNG) as the coolant in a resistive cryogenic cable. The transient thermal response of the cable to a variety of system disturbances is considered. In the present configuration, LNG flows on the inside of three hollow, aluminium, cylindrical conductors operating at 230 kV and arranged in a symmetric configuration inside an external vacuum casing. Each conductor carries

a single phase and is suitably isolated from the environment, both thermally and electrically. The thermodynamic and transport properties of the LNG are approximated by those of methane. The behavior of the cable is described by a system of partial differential equations coupled via the rate equations for heat transfer between the conductors and the LNG. Steady-state temperature and pressure profiles along a 10 kilometer cable length are developed for various current ratings. Possible overloading mechanisms are presented. Transient temperature and pressure profiles in the LNG as well as the temperature profiles in the conductors are developed for a variety of system disturbances, including current overload of the conductors, loss of vacuum dielectric and thermal insulation, and flow interruption of the coolant. For each case, temperature and pressure profiles along the entire 10 kilometer cable length are evaluated for the duration of the transient.

DC SYSTEMS

REFER ALSO TO CITATION(S) 32305

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

REFER ALSO TO CITATION(S) 32864, 32865

32305 (BMFT-FB-T—76-01) **Studies on low temperature cable for power transmission. Final report.** Franke, H.; Hildebrandt, U.; Kuhmann, H.; Scheffler, E.; Voigt, H.; Bochenek, E. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Frankfurt am Main (Germany, F.R.). Bereich Forschung und Entwicklung; Allgemeine Elektricitaets-Gesellschaft AEG Telefunken Kabelwerke A.G., Rheydt (Germany, F.R.); Kabel- und Metallwerke Gutehoffnungshuette A.G., Hannover (Germany, F.R.); Linde A.G., Hoellriegelskreuth/Muenchen (Germany, F.R.)). Jan 1975. 224p. (In German). Dep. NTIS (US Sales Only) $7.75.

The first phase of the development project of a high power cable with superconductors was finished by developing the cable components. Theoretical studies for the layout, technological, experimental and design studies for a flexible, contraction-compensated dc-cable, the termination, the joints and the peripheral equipment were made. Test cables were manufactured. The current-carrying capacity of the cable was tested in a experimental setup. Cable and terminations were installed for making voltage tests. An energy-economic study was made.

32306 **Free convection heat transfer to supercritical helium.** Halal, M.A.; Boom, R.W.; El-Wakil, M.M. (Univ. of Wisconsin, Madison). pp 327-329 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

It is desirable to use supercritical helium as a coolant for large extended systems, such as superconducting transmission lines. The use of supercritical helium will minimize the amount of helium required and it will also eliminate troublesome phase changes. Supercritical helium as a coolant may be forced to flow through conduits or channels and heat is transferred by free or forced convection. Free convection will be the predominant heat transfer mechanism for Gr/Re^2 greater than or equal to 1, where Gr and Re are the Grashof and Reynolds numbers, respectively. Even for Reynolds numbers of 10^5, such conditions can be easily reached with supercritical helium because of the large thermal expansivities and the small kinematic viscosities encountered. For large conduits and reasonable flow rates of supercritical helium, the heat transfer will be mainly by free convection. The study of cryogenic free convective heat transfer from a sphere to supercritical helium is reported. The free convective heat transfer coefficient was measured within the following region: 4.2 to 25°K and 3 to 35 atmospheres, which is the supercritical region. Measurements were made for sphere to helium temperature difference of 0.1 to 7°K.

32307 **Electrical properties of cryogenic cable insulation.** Thoris, J.; Bobo, J.C.; Fallou, B. (Laboratoires de Marcoussis, France). pp 360-361 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

UHV power transmission will meet in the near future some problems of environment and of unit power handling capacity of cables. These problems could be solved by using cables; however, complementary data seem necessary about the cable itself, bushings, and spacers. The present work involves measurements on tan delta, transverse and axial breakdown voltage of multilayer or solid dielectrics in liquid or two-phase helium for different pressures. The characteristics of materials which are responsible for the behavior of the electrical insulation are described. Some results concerning different structures of insulation, which were gradually adapted to obtain an optimum behavior, are presented.

32308 **Experimental superconducting dc and ac cables.** Kirschner, I.; Laszloffy, L.; Bankuti, J.; Kiss, G.; Kovacs, I. (Roland Eotvos Univ., Budapest). pp 515-517 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

In the interest of realization of superconducting power transmission lines, experiments have been performed for some years in Hungary, at the Laboratory for Low Temperature Physics. Three cables were constructed, one of them is a dc type of 5 MW transmission power, the other is a single-phase ac cable system of 100 MVA, and a three-phase cable section was built for 48.6 MVA power transmission.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 32275, 32722, 32727, 32728, 32738, 32739

32309 (AED-CONF—75-769-050) **Integrated project management type contracts.** Heisler, S.I. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 12p. (CONF-7509129—120). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

The concept of integrated project management represents a single source to which the owner can turn for all project management functions excepting for those relating to outside parties such as site purchase, personnel selection etc. Other functions such as design, procurement, construction management, schedule and cost control, quality assurance/quality control are usually handled by the integrated project manager as the agent of the owner. The arrangement is flexible and the responsibilities can be varied to suit the size and experience of the owner. Past experience in the United States indicates an increase in the trend toward IPM work and it appears that overseas this trend is developing also.

32310 (AED-Conf—75-769-102) **Classification of power reactors and nuclear power plants' general structure.** Roehl, F. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 12p. (CONF-7509129—121). INIS.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

The paper deals with the main features of different reactor types and discusses the general structure of power stations.

32311 (EUR—5476-d) **Structure, equipment and organisation of the personnel employed for inspection, maintenance and repair in the control area of nuclear power plants.** (Commission of the European Communities, Brussels (Belgium)). Jun 1976. 46p. (In German). NTIS (US Sales Only).

A survey of personnel problems which have arisen during inspection, maintenance and repair work in the control area of nuclear power plants in the European Community is presented. The following aspects have been investigated: determination of the number of personnel employed for the different activities during certain time periods (years); allocation of the personnel employed according to its provenance (own personnel of the nuclear power plant, supplier's personnel, personnel hired by the nuclear power plant from other firms); qualification of the personnel employed; preparation of the personnel for specialized work (e.g. special training by means of models). On the basis of these data, which represent the experience gained so far, the future demand of personnel for inspection, maintenance, and repair has been estimated, considering also the growing portion of nuclear power production in total power production. Furthermore this study results in a number of recommendations, which refer to the employment of personnel in the control area.

32312 **Nuclear reactors and their utility in nuclear power plants.** Sangal, S.P. (Laxminarayan Inst. of Tech., Nagpur (India)). *Chem. Age India;* **27**: No. 5, 441-450(May 1976).

7 refs.

The article deals with different types of nuclear reactors and their use to produce electricity. Various components such as fuel, control elements and the coolants are discussed in detail.

32313 **Reactor with a water moderator.** Berens, T.; Maansson, R. (to ASEA-ATOM AB). Swedish Patent 384,593. 10 May 1976. 6p. (In Swedish).

Description is given of a reactor with a water-moderator, comprising a pressurized container with several fuel assemblies contained in a vessel, positioned by means of a core-grid, together with a spraying device. That reactor is characterized in that a large number of spraying pipes are hydraulically and mecanically connected to respective auxiliary pipes situated above and spraying pipes, by means of several transverse metal pipes.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 32553, 32580, 32582, 32583, 32585, 32598, 32599, 32608, 32609, 32610, 32611, 32612, 32614, 32615, 32616, 32617, 32618, 32619, 32620, 32621, 32628, 32629, 32632, 32657, 32659, 32664, 32668

32314 (AD-A—030161) **Structural integrity of water reactor pressure boundary components. Progress report for period ending 31 May 1976.** Loss, F.J. (Naval Research Lab., Washington, D.C. (USA)). Sep 1976. Contract AT(49-24)-0207. 51p. (NRL-MR—3353;NRL-NUREG—2). NTIS $4.50.

This report describes progress in a program to characterize material properties performance with respect to the structural integrity of light water reactor pressure boundary components. The work is sponsored primarily by the U.S. Nuclear Regulatory Commission. Studies on dynamic fracture toughness are also being conducted on a cooperative basis between the Electric Power Research Institute and NRL. Additional support for the dynamic fracture toughness studies is provided by the Office of Naval Research. This report describes progress in the following areas: Warm prestress investigations related to thermal shock of a vessel; fracture toughness degradation of commercial weld deposits following low fluence irradiation; auger spectrography study on the mechanism of phosphorus contribution to steel radiation sensitivity; elastic analysis of three-point bend specimens subject to impact loading; and a survey of reactor materials research underway at two foreign laboratories.

32315 (ERGPRO-nn—2) **Experience with fuel elements. IAEA Symposium: Experience from operating and fuelling nuclear power plants.** Schwarz, R. (Energoprojekt, Prague (Czechoslovakia)). Feb 1975. 7p. (In Czech). U PC A02/MF A01.

Translated from At. Strom (1974) (no. 3/4) p. 30-31. Available from Energoprojekt, Prague, Czechoslovakia.

A brief description is given of the operating experience with fuel elements of light-water, gas-cooled, and heavy-water reactors. The failures are depicted of fuel elements in nuclear power plants with reactors of these types.

32316 (EUR—5418) **Garigliano nuclear power plant. Annual report 1973.** (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar 1976. 14p. (In Italian). INIS.

During the period under review, the Garigliano power station produced 1,028,77 million kWh with a utilization factor of 73,41% and an availability factor of 85,64%. The disparity between the utilization and availability factors was mainly due to a shutdown of about one and half months owing to lack of staff at the plant. The reasons for nonavailability (14.36%) break down as follows: nuclear reasons 11,49%; conventional reasons 2,81%; other reasons 0,06%. During the period under review, no fuel replacements took place. The plant functioned throughout with a single reactor reticulation pump and resulting maximum available capacity of 150 MWe gross. After the month of August, the plant was operated at levels slightly below the maximum available capacity in order to lengthen the fuel cycle. The total number of outages during the period under review was 11. Since the plant was brought into commercial operation, it has produced 9.226 million kWh.

32317 (INIS-mf—3224, pp 99-100) **Burnup dependence of stored energy and gas pressure in LWR fuel rods.** Wunderlich, F.; Holzer, R. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32318 (ORGREZ-nn—1) **Extent and methods of repair planning of nuclear power plants under construction of the Hamburgische Elektrizitaets-Werke.** Kiesling, J. (ORGREZ, Brno (Czechoslovakia)). [nd]. 9p. (In Czech). TIC.

Translated from VGB Kraftwerktechnik (May 1974) v. 54(5). Available from ORGREZ, Brno, Czechoslovakia.

The gradual commissioning of large nuclear power plants brings up the very important question of the perfect preparation and prompt implementation of preventive maintenance which in many aspects differs considerably from similar work in conventional power plants. The method of preventive maintenance is described as suggested and developed by the Hamburgische Electrizitaets-Werke for its nuclear plants which are currently under construction. Special attention is focused on the training and use of personnel.

32319 **Steam volume and pressure drop in bubble flow.** Moussalli, G. Karlsruhe, Germany; Karlsruhe University (21 Jul 1975). 127p. (In German).

Thesis.

The paper describes a method of determinig the pressure drop of a bubble or slug flow in tubes or capillaries. It applies to all types of two-phase systems. Experimental measurements are carried out in air/water and air/oil mixtures.

32320 **Experience in welding the primary components of light water reactors.** Cerjak, H.; Debray, W.; Pellkofer, D. (Kraftwerk Union, Erlangen, Ger). *Schweissen Schneiden;* **27**: No. 8, 296-300(Aug 1975). (In German).

It is stated that the primary components of light water reactors are all constructed by welding. They are steel forgings, steel castings, or low alloy fine-grain steel sheet joined by welding. A pictorial flow sheet of welding and testing operations is given. Quality control methods for electrodes and filler metals are similarly discussed. Relaxation embrittlement is dealt with as an example of a possible source of defects, and the test to discover this condition is described. Special welding techniques such as weld cladding in two layers and special materials have been developed.

32321 **Spacer capture system for nuclear fuel assemblies.** Long, J.W.; Flora, B.S. (to Exxon Nuclear Co., Inc.). US Patent 3,984,284. 5 Oct 1976. Filed date 3 Aug 1973. 4p.

A spacer capture system for nuclear fuel assemblies is described in which fuel rods are disposed in parallel array between supporting end plates. At intervals along the fuel rods spacer grids are provided which properly position the fuel rods, reducing vibration and obtaining proper spacing to assure uniform heat removal from the fuel rods during operation. The spacers hold the fuel rods by spring pressure against protrusions formed from the side walls of the grids. The spacers are held in the proper position against vibration and the force of water passing adjacent the tubes by lugs provided on special fuel containing spacer capture rods which engage the protrusions on each spacer and thereby preventing its longitudinal movement relative to the fuel rods. The lugs are so mounted as to permit freeing of the spacer capture rods by a 45° rotation of the spacer capture rods and conversely, the spacers may be locked in position by a 45° rotation of the spacer capture rods from the unlocked position. In a region in which the locking lugs are provided, inert material replaces the nuclear fuel material in order to avoid overheating of the tubes.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 32314, 32315, 32317, 32320, 32321, 32449, 32546, 32550, 32580, 32582, 32583, 32584, 32585, 32598, 32599, 32602, 32608, 32609, 32610, 32611, 32612, 32614, 32615, 32616, 32617, 32618, 32619, 32620, 32621, 32622, 32623, 32624, 32625, 32628, 32629, 32632, 32660, 32661, 32664, 32665, 32668, 32801

32322 (AED-Conf—74-570-000, pp 4-36) **Problems of materials and finishing in the production of straight-tube heat exchangers.** von Moeller, W.; Wenzel, H. (Babcock - Brown Boveri Reaktor G.m.b.H., Mannheim (F.R. Germany)). 1974. (In German).

From VGB conference on materials and welding in power plants - VGB materials conference; Duesseldorf, F.R. Germany (26 Nov 1974).

17 figs.; 3 tabs.; 21 refs. Available from ZAED.

In VGB conference on materials and welding in power plants 1974 - VGB materials conference 1974. Papers.

The straight-tube steam generator with forced circulation and integrated economiser is an advanced type of heat exchanger for PWR reactors. The materials for its components are the same as for U-tube steam generators. The use of Inconel 600 as a piping material has been a matter of controversy in Germany in the last few years, and extensive studies on stress crack corrosion have therefore been caried out. Information obtained in worldwide laboratory tests and operational experience proves that Inconel 600 is the best of all available materials for the tubes of straight-tube steam generators. The heat treatment at 600°C of the finished steam generator during stress relief annealing improves its resistance to stress crack corrosion and lowers the residual stresses until they are well below the threshold value inducing stress crack corrosion.

32323 (DEU—76-24) **Annual report on the 8th business year from 1st October 1974 till 30th September 1975.** (Kernkraftwerk Stade G.m.b.H. (KKS) (Germany, F.R.)). 1976. 28p. (In German). INIS.

With figs. Available from ZAED.

The nuclear power plant Stade has produced the total of 4,883 GWh in its 8th business year and delivered 4,636 GWh of this to the partners Nordwestdeutsche Kraftwerke AG and Hamburgische Electricitaets-Werke AG. The total electricity production from the start-up of the plant in spring 1972 to the end of the period under report (30.9.75) reached 16,151 GWh, the utilizable current delivery to the partners during the same time was 15,330 GWh. As in the previous years, the nuclear power plant could be operated with full load nearly without interruption - with exception of the stretch-out-operation from March to April 1975 -. The highest current production in the business year was reached in October 1974 with 495,460 MWh. In the period under report, the availability again reached the value of the previous year with 87%. During October and November, 1974, and April, 1975, it even amounted to 100%. The non-availability of 13% is mainly due to the refuelling and revision in 1975. This shutdown required 11% of the possible yearly operating hours with 990 operating hours.

32324 (EUR—5419) **Ardennes nuclear power plant. Annual report 1974.** (Societe d'Energie Nucleaire Franco-Belge des Ardennes, 08 - Chooz-lez-Givet (France)). Mar 1976. 24p. (In French). INIS.

Generally speaking, the operation of the installations is very satisfactory. The prolongation of the scheduled shutdown was mainly due to the work in progress in the reactor vault, the purpose of which is to strengthen the supporting structures of the pipework and primary pumps in the case of a reference accident (work requested by the safety authorities with a view to authorizing an increase in output to 1040 MWth). Over the last five years net production has amounted to 8600 GWh. It corresponds to an average availability factor of 72%.

32325 (EUR—5496) **Obrigheim nuclear power plant. Annual report 1974.** (Commission of the European Communities, Luxembourg). May 1976. 72p. (In German). INIS.

The gross output of the 345MW(e) pressurized water nuclear power station at Obrigheim, operation on base load, amounted to about 2.57TWh in 1974, the net power fed to the grid being about 2.44TWh. The core was used to its full capacity until 10 May 1974. Thereafter, the reactor was on stretch-out operation with steadily decreasing load until refuelled in August 1974. Plant availability in 1974 amounted to 92.1%. Of the 7.9% non-availability, 7.87% was attributable to the refuelling operation carried out from 16 August to 14 September and to the inspection, overhaul and repair work and the routine tests performed during this period. The plant was in good condition. Only two brief shutdowns occurred in 1974, the total outage time being 21/2 hours. From the beginning of trial operation in March 1969 to the end of 1974, the plant achieved an availability factor of 85.2%. The mean core burnup at the end of the fifth cycle was 19600 MWd/tonne U, with one fuel element that had been used for four cycles achieving a mean burnup of 39000 MWd/tonne U. The sipping test on the fuel elements revealed defective fuel-rods in a prototype plutonium fuel element, a high-efficiency uranium fuel element and a uranium fuel element. The quantities of radioactive substances released to the environment in 1974 were far below the officially permitted values. In July 1974, a reference preparation made up in the nuclear power station in October 1973 was discovered by outsiders on the Obrigheim municipality rubbish tip. The investigations revealed that this reference preparation had very probably been abstracted from the plant in October 1973 and arrived at the rubbish tip in a most irregular manner shortly before its discovery.

32326 (FRNC-TH—617) **Melodie. Experiment carried out in the Minerve reactor for neutron measurements on water reactor fuels.** Dayday, N. (Paris-11 Univ., 91 - Orsay (France)). 1973. vp. (In French). NTIS (US Sales Only).

A small size fuel assembly for which neutron characteristics in the central part are similar to those of the irradiated pins of the SENA reactor when they were unloaded was defined and developed in view of measuring irradiated fuel samples, reconstituted samples containing plutonium, and calibrated samples. Buckling and spectrum index measurements confirmed that neutron conditions reach an equilibrium in the central part, and confirmed the validity of the parameters calculated. The interpretation of the buckling measurements using the Apollo code and taking into account most recent fits leads to a very small experiment-calculation deviation. Agreement was also obtained between spectrum index measurements and Apollo code values except for the fission of ^{238}U. Oscillation methods have allowed the measurement of reactivity effects in the different samples with a very good accuracy. A method that assumes that the neutron flux inside the samples is nearly equal to that of the non-perturbed case was used to interprete the oscillation results. It was shown that isotope composition and sample masses must be precisely known, and that self-shielding effects are important in the case of ^{239}Pu and ^{240}Pu.

32327 (IHZ-K—75-67) **Analytical model for studying noise effects in PWR type reactors.** Meyer, K. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). Oct 1975. 20p. (In German). U PC A02/MF A01.

An analytical model based on the one-group diffusion method is described. It has been used for calculating the axial dependence of the spectral density of the ionization chamber noise supposing a site-independent stationary neutron flux distribution. Coolant inlet temperature fluctuations are considered as noise sources.

32328 (INIS-mf—3224, pp 95-96) **Characterization of normal fuel rod behaviour.** Roberts, J.T.A.; Gelhaus, F.E.; Zebroski, E.L. (Electric Power Research Inst., Palo Alto, Calif. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 4 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32329 (INIS-mf—3224, pp 78-79) **Behaviour of zircaloy clad UO_2 fuel rods during film boiling in a PWR environment.** Quapp, W.J.; McCardle, R.K. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32330 (ZJE—169) **Measurement of pressure pulsations in PWR reactors.** Haniger, L. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1975. 13p. U PC A02/MF A01.

The problem is discussed of measuring pressure pulsations in light-water reactors of the PWR type. A piezoelectric transducer and a charge-sensitive amplifier which form the basic measuring channel for pressure pulsation measurement are described. In addition charge sensitivity of the amplifier, the problem of long-term drift, and the frequency response as well as the design of the amplifier are discussed. The amplifiers described were tested under laboratory conditions and are considered to be the first development stage of a pressure pulsation measuring system.

32331 **Foam shock absorbers for lower inlet doors of nuclear reactor ice condenser compartments--design considerations.** Rudd, G.E.; Meier, J.F. (Westinghouse Res Lab, Pittsburgh, Pa). *J. Cell. Plast.;* **11**: No. 3, 143-151, 164(May-Jun 1975).

If a large steam line in the nuclear containment should rupture, 360-pound doors leading to the Ice Condenser Compartment would be flung open violently, and it is required that they be stopped without severe damage to the doors or the supporting structure. For this purpose, a low density phenolic foam shock absorber was designed, developed, and successfully tested under simulated accident conditions. Shock absorber covers to control the geometry and contain the foam fragments are part of the design. The paper describes the shock absorber design and presents the results of the full-scale tests.

32332 **Nuclear boiler.** Andrieu, J.L.; Bonnet, Y.; Viaud, M. (to CEA). French Patent 2,282,698/E/. 22 Aug 1974. 10p. (In French).

Addition to the French patent document 7428862. Available from Institut National.

The nuclear boiler described includes a pressure vessel housing the core of the boiler closed at its upper part by a cover. A primary coolant flows through it. It also contains a number of pumps to move the liquid. This boiler comprises a massive circular part forming the upper section of the side shell of the vessel. This part is provided with a number of radial through holes equal in number to that of the generators fixed to the connecting side opposite the radial holes. The circulation pumps are integral with the water tank of the steam generators. Each generator has at least one pump the casing of which is integral with the water tank of the steam generator.

32333 **Process and system for introducing gaseous hydrogen into water applicable in particular to the hydrogenation of the pressurized water of a nuclear reactor.** Dolle, L.; Kahan, H.; Rozenberg, J.; Vignet, P. (to CEA). French Patent 2,285,172/A/. 20 Sep 1974. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The description is given of a process for introducing hydrogen into water, the salient feature being that a current of gaseous hydrogen and a current of water are made to flow across a membrane in palladium based material so as gaseous hydrogen diffuse in the water by passing through the membrane. The palladium and

silver alloy contains 77% palladium and 23% silver by weight. This apparatus includes a tubular cell respectively comprising at each of its ends a water intake and an outlet pipe and a membrane located inside the cell. Each end of the tube is connected respectively to a gaseous hydrogen supply pipe and a bleed tube. This process applies to the hydrogenation of the pressurized water of a nuclear reactor.

32334 Experimental and theoretical methods for assessment of flow induced vibrations of nuclear reactor internal structures. Jeanpierre, F.; Livolant, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 1-11 of In Structural mechanics in reactor technology. Vol. II. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

For water and sodium cooled nuclear reactors, the coolant flow is one of the main sources of vibrations. This paper presents the methods in current use at the French CEA for the estimation of those vibrations. The first step is to estimate the excitation forces due to the fluctuating pressure and to characterize them by an intensity, a spectrum shape, and a correlation length. Various types of flow singularities have been tested in the Vibrations Laboratory and the corresponding pressure fields measured and analysed. Extrapolations to other geometries are generally possible, at least to give a first estimate. The second step is to calculate the resonant frequencies and modes of the structures. The problem is complicated here by the liquid effects which are generally very important (a factor of three or more on the resonant frequencies). A computational technique using the modal coupling of structures, and taking into account the liquid effects by special finite elements is presented in the paper, with some applications to PWR and sodium cooled reactors. The last step is to calculate the vibrational amplitude of each mode by integration of the random pressure field on the modal displacement shapes, and consequently to obtain an estimate of the RMS displacements and strains of the structures. The results obtained by the calculation method described here are favourably compared with the experimental results obtained on the Phenix reactor and the SAFRAN loop for PWR internal tests.

32335 Fuel cluster for nuclear reactor core. Smith, B.A.; Lass, J.L. (to General Electric Co.). French Patent 2,286,475/A/. 29 Sep 1975. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 30 Sep 1974, US.

The components described are intended to maintain the rods to a given lattice in a fuel cluster to be employed in a nuclear reactor. The upper end of each rod comprises a stem with a diameter less than that of the rod and designed to fit into a maintaining piece of the upper supporting plate, the stem diameter of each rod corresponding uniquely to the enrichment of the fuel contained in the associated rod. The maintaining fitments of the upper supporting plate include housings of similar diameter and diameter reducing adapters fitted to each housing. The respective internal diameters of the adapters are selected to take stems of a diameter suitable to ensure a given enrichment distribution of the fuel rods in the fuel clusters. The diameter of the stems of the fuel rods containing fuel of a given enrichment is greater than that of the stems of the rods containing lower enrichment fuel. At least one stem includes a continuous hollow tube provided with apertures allowing the coolant to flow inside this stem. This system is particularly intended for pressurized water reactors.

32336 Development trends of steam generator for PWR type reactors. Review. Krzhizhek, V. *At. Tekh. Rubezhom;* No. 10, 3-9(Oct 1975). (In Russian).

9 figs.; reduced translation from Jad. Energ., 1975, v. 21, no. 2, p. 44.

32337 Operating costs of nuclear power stations. Feron, J. (Electricite de France, 75 - Paris. Direction de la Production et du Transport). pp 72-77 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976). (In French)

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

A cost analysis for the production of electricity in a nuclear power plant consisting of several 925 MW(e) PWRs is presented. The assumptions under which the various cost elements (capital costs, availability, operating cost, fuel cost) are calculated are stated, and the effect on the total cost of varying these assumptions is given. It is concluded that for any reasonable variations the cost of electricity is considerably lower for nuclear power plants than for fossil plants.

32338 Public announcement of the planned erection and operation of a nuclear power plant on the village lands of Vahnum near Wesel (Kernkraftwerk Vahnum). *Bundesanzeiger;* **28**: No. 192, 4(Oct 1976). (In German).

The RWE intends to erect and to operate in Vahnum near Wesel a nuclear power plant with two PWRs and two natural-draught cooling towers. The thermal capacity of each block is to be 3,765 MWth, the electrical net capacity 1,232 MWe.

32339 Nuclear reactor of pressurized liquid coolant type. Costes, D. (to Commissariat a l'Energie Atomique). US Patent 3,988,202. 26 Oct 1976. Priority date 30 Mar 1973, France. 8p.

The reactor comprises a vertical concrete pressure vessel, a bell-housing having an open lower end and disposed coaxially with the interior of the pressure vessel so as to delimit therewith a space filled with gas under pressure for the thermal insulation of the internal vessel wall, a pressurizing device for putting the coolant under pressure within the bell-housing and comprising a volume of control gas in contact with a large free surface of coolant in order that an appreciable variation in volume of liquid displaced within the coolant circuit inside the bell-housing should correspond to a small variation in pressure of the control gas. 9 claims, 3 drawing figures.

32340 Small reactors extend the market for nuclear power. Bauyat, J.; Raoul, J.P. (Alsthom-Atlantique). *Nucl. Eng. Int.;* **21**: No. 251, 65-69(Dec 1976).

Countries with relatively low electricity consumptions, desalination plants, combined steam and power production in industry and ship propulsion are among the applications for small nuclear reactors based on the PWR design. They are factory assembled and tested and can be installed on floating platforms or on land. The CAS 3G design is described which has three coolant loops and uses plate-type multi-chambered Zircaloy-contained oxide fuel.

32341 Detailed neutron noise analysis of pressurized water reactor internal vibrations. Mayo, C.W. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.; Babcock and Wilcox Co., Lynchburg, Va. (USA). Power Generation Group). *Atomkernenergie;* **29**: No. 1, 9-13(1977).

6 figs.; 11 refs.

A multiple noise source model was developed for neutron noise analysis of pressurized water reactor internal vibrations. The phase and coherence properties of the major neutron noise sources were identified and used to predict properties of the measured spectra. These suggest a method to separate the measured spectra into process noise spectra. This technique was applied to plant data and the results compared to conventional cross spectral measurements. Several related techniques for detailed motion analysis are also discussed. These methods define a general approach for detailed neutron noise analysis of pressurized water reactor internal vibrations.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 32107, 32315, 32443, 32544, 32628, 32630, 32662, 32730, 32833

32342 (AED-Conf—76-407-011) **Supply of densely populated areas with nuclear long-distance energy.** Schulten, R.; Speich, P. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). 1976. 11p. (In German). (CONF-7609113—1). NTIS (US Sales Only).

From Congress on rational energy utilities in urban systems with specialized exhibition at the German Industrial Exhibition; Berlin, German, Federal Republic of (F.R. Germany) (18 Sep 1976).

6 figs.; 6 refs.

A survey is presented of the various possibilities of energy transmission from nuclear power plants. The main possibilities are energy supply by means of a closed system, by an open system, and the simultaneous generation of long-distance energy, short-range heat, electric current, and process vapour. The HTR as a source of energy is prominent in this context.

32343 (CEA-CONF—3432) **High-temperature reactors. Activities in France on the steam cycle HTR.** de Lacoste Lareymondie; Guennec, N.; Rastoin, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). 1975. 11p. (In French). NTIS (US Sales Only) $3.50.

From Nuclex 75. 4. International fair and technical meeting on nuclear industries; Basle, Switzerland (7 Oct 1975).

Although French activities cover all the possibilities of high-temperature reactors the effort of the last few years has been concentrated on the steam cycle electricity-generating version. This work, closely coordinated with that of General Atomic in application of agreements settled in 1972 and 1973, was devoted to engineering as a result of the assimilation of American technique by French industry and to research and development owing to the joint CEA and GA programme. After an examination of these two centers of activity the reasons which will lead to a closer collaboratin among the European partners of General Atomic are expressed in conclusion.

32344 (CEA-CONF—3531) **Hydrogen production by water-splitting and HTGR.** Courvoisier, P.; Rastouin, J.; Tilliette, Z.C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). 1976. 23p. INIS.

From International conference on advanced nuclear energy systems; Pittsburgh, Pa., USA (14 Mar 1976).

Some aspects of the use of heat of nuclear origin for the production of hydrogen by water-splitting are considered. General notions pertaining to the yield of chemical cycles are discussed and the heat balance corresponding to two specific processes is evaluated. The possibilities of high temperature reactors, with respect to the coolant temperature levels, are examined from the standpoint of core design and technology of some components. Furthermore these reactors can lead to excellent use of nuclear fuel. The coupling of the nuclear reactor with the chemical plant by means of a secondary helium circuit gives rise to the design of an intermediate heat exchanger, which is an important component of the overall installation.

32345 (EUR—5422) **Latina nuclear power plant. Annual report 1974.** (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar 1976. 13p. (In Italian). INIS.

In the period under review, the Latina power plant produced 1009,07 million kWh with a utilization factor of 72% and an availability factor of 80,51%. The disparity between the utilization and availability factors was mainly due to the shutdown of the plant owing to trade union strife. The reasons for non-availability (19,49%) were almost all related to the functioning of the conventional part and the general servicing of the plant (18 September-28 October). During the shutdown for maintenance, an inspection of the steel members and parts of the core stabilizing structure was made in order to check for the familiar oxidation phenomena caused by CO_2; the results of the inspection were all satisfactory. Operation of the plant during 1974 was marked by numerous power cutbacks as a result of outages of the steam-raising units (leaks from the manifolds) and main turbines (inspection and repairs to the LP rotors). Since it was first brought into commercial operation, the plant has produced 13,4 thousand million kWh.

32346 (EUR—5499) **Ten year report on the operation of the Latina nuclear power station 1964—1973.** (Commission of the European Communities, Brussels (Belgium)). Jul 1976. 14p. (In Italian). NTIS (US Sales Only).

The final report on the operation of the Latina nuclear power station, required under the terms of the contract of participation between ENEL and EURATOM is presented. It covers the first ten years of commercial operation (1 January 1964-31 December 1973) of this power station. Latina uses a British Magnox-type gas-graphite natural uranium reactor with a design thermal capacity of 724 MW. The rated electrical output of the three main turbogenerators was originally 210 MW (3x70), but was reduced to 160 MW in 1971. Construction began in November 1958 and was completed when the reactor first reached criticality in December 1962, the station being connected to the Italian electricity network for the first time in May 1963. The gross rated output of 210 MWe was reached in December 1963 and commercial operation began on 1 January 1964, by which date, however, the power station had already fed 295.5 million kWh into the network.

32347 (GA-A—14192) **Potential effect of wet/dry cooling on economic incentives for the gas turbine HTGR.** Schoene, T.W. (General Atomic Co., San Diego, Calif. (USA)). Dec 1976. Contract EY-76-C-03-0167-046. 21p. Dep. NTIS $3.50.

A reference wet/dry cooling system for the Gas Turbine HTGR (GT-HTGR) is presented. The reference system was selected to minimize the design impact on the existing GT-HTGR design and to expedite a preliminary evaluation of the economics of the system. The reference system is identical to the all-dry system, except that a wet cooling tower is used to further cool the water from the dry cooling tower via an intermediate water-to-water heat exchanger.

32348 (Juel—1318) **Investigations on a metal foil insulation in the ARGAS plant and in the pressure-release test stand.** Henssen, J.; Lonzen, G.; Lang, H.; Noack, G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor mit Heliumturbinen). Jul 1976. 50p. (In German). U PC A03/MF A01.

28 figs.; 6 refs.; with tabs.

The topics of the test plants were investigations on a fiber insulation determined by the boundary conditions of the HHT project. Amongst others this involved the testing of an insulation on metal foil basis in bobbin construction. The aim of the investigations on this insulation in both pilot plants was for one, the testing at high gas temperatures (up to 950°C) with regard to the thermal behaviour. The other, to obtain statements on the behaviour of the insulation with fast sinking pressure.

32349 (Juel—1323) **Application of two-phase-diffusion to describe the release of cesium from spherical HTR-fuel elements.** Uhlenbusch, L. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor mit Heliumturbinen; Technische Hochschule Aachen (Germany, F.R.)). Jul 1976. 74p. (In German). INIS.

12 figs.; 6 tabs.; 31 refs.

For the theoretical prediction of fission product release from HTR-fuel elements the one-dimensional diffusion code SLIPPER has been developed, which describes the transport of fission products optionally by one- or two-phase diffusion. The mathematical-physical basis and general program-technical aspects are represented. The application of the code to irradiation experiments with spherical fuel elements in the Studsvik R2-reactor shows that the experimentally measured concentration profiles and fractional releases of the isotope Cesium 137 can be very well reproduced by two-phase diffusion. The used transport data for the fuel particles are in good agreement with reference values; on the other hand, the diffusion coefficients of matrix graphite are much smaller than those measured for unirradiated reference samples.

32350 (LA-NUREG—6685-MS) **Methods for calculating group cross sections for doubly heterogeneous thermal reactor systems.** Stamatelatos, M.G.; LaBauve, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 63p. Dep. NTIS $4.50.

The report discusses methods used at LASL for calculating group cross sections for doubly heterogeneous HTGR systems of the General Atomic design. These cross sections have been used for the neutronic safety analysis calculations of such HTGR systems at various points in reactor lifetime (e.g., beginning-of-life, end-of-equilibrium cycle). They were also compared with supplied General Atomic cross sections generated with General Atomic codes. The overall agreement between the LASL and the GA cross sections has been satisfactory.

32351 (SRD-R—41, pp Paper no.SNI 3/15) **Experience with and reliability of the gas circulation function in the St. Laurent reactors.** Blin, A.; Grand, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire); Oget, M. Jan 1975. (In French).

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A description is given of a special method for checking incidents in the St Laurent reactors and the creation of a store of data based on operating incidents, in order to improve knowledge concerning breakdown and equipment failures. A five year analysis of incident statistics suggest that it would be profitable to extend the method to other similar stations, to standardize the information and adopt a unified approach to compiling the records for centralised processing. The principles of the St Laurent gas circulation function and their use under both normal and emergency conditions are discussed. Their performance in service is examined and their reliability is investigated. A calculation based on rates of failure and operation repairs over five years shows the probability of a total loss of function of the turboblowers to be of the order of 4×10^{-4} per y.

32352 **Process for producing metal oxide kernels and kernels so obtained.** Lelievre, B.; Feugier, A. (to Compagnie pour l'Etude et la Realisation de Combustibles Atomiques (CERCA)). French Patent 2,284,956/E/. 10 Sep 1974. 4p. (In French).

Addition to the French patent document 7430526. Available from Institut National de la Propriete Industrielle, Paris (France).

The process desbribed is for producing fissile or fertile metal oxide kernels used in the fabrication of fuels for high temperature nuclear reactors. This process consists in adding to an aqueous solution of at least one metallic salt, particularly actinide nitrates, at least one chemical compound capable of releasing ammonia, in dispersing drop by drop the solution thus obtained into a hot organic phase to gel the drops and transform them into solid particles. These particles are then washed, dried and treated to turn them into oxide kernels. The organic phase used for the gel reaction is formed of a mixture composed of two organic liquids, one acting as solvent and the other being a product capable of extracting the anions from the metallic salt of the drop at the time of gelling. Preferably an amine is used as product capable of extracting the anions. Additionally, an alcohol that causes a part dehydration of the drops can be employed as solvent, thus helping to increase the resistance of the particles.

32353 **Comparison of two methods of analysing three-dimensional cracking in the concrete pressure vessel.** Bindseil, P. (Krupp (Friedr.) G.m.b.H., Essen (Germany, F.R.)); Hansson, V. (Bochum Univ. (Germany, F.R.)). pp 1-11 of In Structural mechanics in reactor technology. Vol. III. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

For the THTR-prestressed concrete pressure vessel three-dimensional calculations of the upper section assuming cracking have been performed for overload in addition to service conditions. For these calculations and for cross-checking them different types of calculation methods were used. For the first calculation a finite element program has been used. The development of the cracks is considered as a sudden change of the original system into a new one. All external loads and internal forces ('eigenstresses') acting in the moment of change are set on the new system. The second calculation is performed with a program based on the dynamic relaxation method. With a relaxation method using equilibrium elements alterations of the system and stored stresses resulting from earlier loadings may be considered easily. The behaviour of cracked zones in this calculation is idealized by a fictive orthotropic material law. Forces in the reinforcement bars are related to an average stress for the section of an element and the corresponding stiffness is introduced perpendicular to the cracks.

32354 Pressed block fuel elements for gas cooled high temperature power reactors and processes for their production. Hackstein, K.G.; Hrovat, M. (to Nukem GmbH). US Patent 3,988,397. 26 Oct 1976. Priority date 14 Feb 1972, German, Federal Republic of (F.R. Germany). 4p.

Block fuel elements for high temperature power reactors that can be reprocessed simply are prepared in which the feed and breed zones are connected with the graphite matrix directly and without transition. They are disposed separately from each other in such a manner that the feed zones and the breed zones can be separately removed one after the other from the structural graphite. In the reprocessing operation there are recovered uranium 233 from the breed particles, uranium 235 and fission products from the feed particles. 1 claim, 4 drawing figures.

32355 Helium cooled nuclear reactors. Longton, P.B.; Cowen, H.C. (to United Kingdom Atomic Energy Authority). US Patent 3,993,540. 23 Nov 1976. Priority date 1 Feb 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A closed loop coolant circuit for a helium cooled high temperature reactor is described. The circuit has a conventional purification by-pass loop including an oxidizing bed for impurities and an absorption bed for the oxidized impurities. A recycle pipe line is provided whereby a fraction of wet gas leaving the oxidizing bed is returned to the main coolant circuit. 8 claims, 5 drawing figures.

32356 Removal of tritium from gas-cooled nuclear reactors. Nieder, R. (to Arbeitsgemeinschaft Versuchsreaktor Avr GmbH). US Patent 3,993,541. 23 Nov 1976. Priority date 31 Jul 1972, German, Federal Republic of (F.R. Germany). 4p.

Tritium contained in the coolant gas in the primary circuit of a gas cooled nuclear reactor together with further tritium adsorbed on the graphite used as a moderator for the reactor is removed by introducing hydrogen or a hydrogen-containing compound, for example methane or ammonia, into the coolant gas. The addition of the hydrogen or hydrogen-containing compound to the coolant gas causes the adsorbed tritium to be released into the coolant gas and the tritium is then removed from the coolant gas by passing the mixture of coolant gas and hydrogen or hydrogen-containing compound through a gas purification plant before recirculating the coolant gas through the reactor. 14 claims, 1 drawing figure.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 32315, 32607, 32626, 32627, 32654

32357 (AECL—5310, pp 2-7) **Modelling nuclear fuel vibrations in horizontal CANDU reactors.** Jagannath, D.V.; Oldaker, I.E. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Feb 1976.

In AECL research and development in engineering, winter 1975.

Flow-induced fuel vibrations in the pressure tubes of CANDU reactors are of vital interest to designers because fretting damage may result. Computer simulation is being used to study how bundles vibrate and to identify bundle design features which will reduce vibration and hence fretting.

32358 (AECL—5398) **Thorium cycle in heavy water moderated pressure tube (CANDU) reactors.** Hatcher, S.R.; Banerjee, S.; Lane, A.D.; Tamm, H.; Veeder, J.I. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). May 1976. 28p. NTIS (US Sales Only).

From American Nuclear Society winter meeting; San Francisco, USA (16 Nov 1975).

7 refs., 15 figs., 3 tables.

The use of thorium fuel cycles in CANDU type reactors will allow much more energy to be extracted from a given amount of fuel than is possible with the present natural uranium cycle. The extent to which various factors affect thorium fuel cycle economics and resource consumption with equilibrium ^{233}U levels in the fuel is considered. Resource consumption in growing nuclear power systems is also considered and it is shown that considerable savings can be achieved even under conditions of rapid growth. The main elements of the development program necessary to provide the technological base for thorium fuel cycles in CANDU type reactors are discussed.

32359 (AECL—5550, pp 21-25) **Low leakage mechanical joint development.** Crago, W.A. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). 1976.

2 refs.

In AECL research and development in engineering.

As a consequence of the development programs described, certain recommendatons for design of mechanial joints have been proposed. These include: 1. Spiral wound gaskets filled with chrysotile asbestos are adequate for primary heat transport system fluid conditions. 2. Spiral wound gaskets should be seated under a stress of 110 to 125 MPa for low leakage performance. 3. Load maintenance, while perhaps reducing leakage, introduces more complex hardware, and is of unproven benefit. 4. Uniform circumferential load application requires the use of hydraulic stud tensioners to ensure satisfactory performance from large size mechanical joints.

32360 (AECL—5550, pp 3-7) **Solving the problem of valve stem leakage.** Dixon, D.F. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). 1976.

8 refs.

In AECL research and development in engineering.

Engineering solutions to valve stem leakage in systems carrying expensive heavy water under pressure have progressed from changing packing brands (failure) to leak collection (partial success) to elimination of small packed valves and an improved valve packing strategy involving stable packing materials, live Belleville spring-loading of packing, and issuance of a detailed stuffing box specification (success).

32361 (AECL—5550, pp 26-30) **Dynamic analysis and simulation at Chalk River.** Green, R.E. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). 1976.

6 refs.

In AECL research and development in engineering.

The paper outlines the role of dynamic analysis/simulation within AECL, discusses briefly some recent dynamic analysis/simulation studies in the Reactor Control Branch at CRNL, describes the dynamic simulation facilities being used by the Branch, and discusses the operation of the Dynamic Analysis Centre and how it might be used by analysts from outside the Reactor Control Branch and indeed, outside AECL.

32362 (AECL—5550, pp 13-16) **Development of heat exchangers for nuclear service.** Hodge, R.I.; Dalrymple, D.G. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). 1976.

In AECL research and development in engineering.

Unusual design constraints, due to tube vibration, are called for when tube-in-shell heat exchangers are incorporated into CANDU type reactor power plants. CRNL has programs studying tube excitation and response, flow conditions, and the fretting process in such exchangers, tube plugging techniques, and eddy current scanning systems for inside bores of full-length tubes.

32363 (INIS-mf—3218) **Ontario Hydro annual report 1975.** (Ontario Hydro, Toronto (Canada)). [nd]. 32p. NTIS (US Sales Only).

A financial report and statistics on Ontario energy demand are presented. Efforts to secure a reliable supply of coal and uranium are described. Ontario Hydro's expansion is now controlled by capital availability and not power demand, and this has affected 11 construction projects, including heavy water plants and nuclear generating stations.

32364 (INIS-mf—3222) **Standardized CANDU 600 MWe nuclear reactor.** Brooks, G.L. (Atomic Energy of Canada Ltd., Ottawa, Ontario). Sep 1974. 48p. INIS.

The potential attractiveness of the 600 MWe CANDU reactor to world markets has led to its adoption as a standard unit design. The design is described in this report.

32365 (INIS-mf—3224, pp 107) **Use of in-pile instruments for monitoring fuel rod performance in the Halden reactor.** Hanevik, A.; Knudsen, K.D. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32366 (INIS-mf—3224, pp 108) **Fuel rod thermal data prior to accident conditions.** Kolstad, E. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water eactor fuel elements under accident conditions.

32367 (K⁻K—2332) **Use of enriched uranium as a fuel in CANDU reactors.** Zech, H.J. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik). Aug 1976. 23p. INIS.

10 figs.; 1 tab.; 9 refs.

The use of slightly enriched uranium as a fuel in CANDU-reactors is studied in a simple parametric way. The results show the possibility of 1) about 30% savings in natural uranium consumption 2) about 35% increase in the utilization of the natural uranium 3) a decrease in fuelling costs to about 70 - 80% of the normal case of natural uranium fuelling.

32368 (SRD-R—41, pp Paper no.SNI 3/5) **Availability analysis of a heat transport pump configuration using Markov models.** Billinton, R.; Lee, S.Y. (Saskatchewan Univ., Saskatoon (Canada)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A systematic method of reliability modelling and calculation using the Markov approach is detailed. It is applied to the heat transport pump configurations of the Bruce generating station. The basic procedure involves establishing a suitable method of state representation and constructing a state space model of the system either by hand or by computer. A computer method, particularly suitable for the construction of large models, was developed and applied to the coolant pump system. The required reliability indices can be determined from the set of linear simultaneous equations derived from the state space model.

32369 (SRD-R—41, pp Paper no.SNI 3/1) **Reliability and maintainability parameters in nuclear power station design.** Krasnodebski, J. (Ontario Hydro, Toronto (Canada)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the evelopment and applicatin of reliability techniques to nuclear plant.

Development of the program and application of Reliability and Maintainability (R and M) engineering to the design of nuclear power stations in Ontario Hydro is described. The effect of unavailability of these stations on the power system and resulting penalties are outlined. Operating experience of Ontario Hydro nuclear power stations and sources of unreliability are briefly reviewed. The R and M program and R and M tasks in design are outlined.

32370 (UJV-mf—1, pp 251 p.) **Temperature shock measurements on the A-1 nuclear power plant primary circuit during reactor start-up.** Kral, A. (Sigma, Prague (Czechoslovakia). Vyzkumny Ustav Cerpacich Zarizeni, Potrubi a Armatur). 1976. (In Czech).

From Seminar on measurement techniques sponsored by Special commitee for fast reactors fluid dynamics and heat transfer; Prague, Czechoslovakia (25 Mar 1975).

Published in microfiche form. Available from Nuclear Information Centre, Praha-Zbraslav, Czechoslovakia.

In Seminar on measurement techniques.

Bohunice A-1 nuclear power plant operates at high temperatures and pressures in the primary coolant circuit. The small heat capacity of the entire coolant circuit and the quick-acting protection system under certain conditions give rise to temperature shocks with a large temperature gradient which may result in transient stress in the primary conduit. The methods are described of measuring these stresses in selected sections of the primary conduit. Also described are the corresponding measuring and processing techniques.

32371 (ZJE—174) **Long-term testing of advanced central fuel channel for the A-1 power station.** Martinek, J. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1976. 29p. U PC A03/MF A01.

A long-term testing of an improved design of the fuel channel for the A-1 nuclear power station, a new design of fuel channel (with particular attention being devoted to its advanced features), experimental devices used in the test, and the program of measurements are described. The results obtained as well as individual stages of the program are described and evaluated.

32372 **Power in Ontario.** *Mod. Power Eng.;* **69**: No. 12, 37-43,46-52(Dec 1975).

Ontario Hydro has begun a $14 billion expansion program needed to meet increased industrial power demands between now and 1980. The expansion will include the addition of nuclear power capacity to Pickering and Bruce CANDU generating stations, 8,600 MW of fossil fired power plants, tripled heavy water production, and several new lines to the 500 kV transmission system.

32373 **Point Lepreau nuclear project unlocks power future of New Brunswick.** Burgess, E.J. (New Brunswick Electric Power Commission, Fredericton (Canada)). *Mod. Power Eng.;* **70**: No. 8, 46-49(Aug 1976).

Projects under development will increase the generating capacity of New Brunswick Electric Power Commission from 1.47 to 3.14 GW. Of these projects, the most significant is the 0.63 GW Point Lepreau CANDU reactor. Progress in the construction of the power reactor is summarized. The concrete reactor building was slipformed in April 1976. A second nuclear unit at Point Lepreau is being considered. Information is also provided on the new oil-fired station at Coleson Cove, a new oil- or coal-fired unit at Dalhousie and further hydro units at Mactaquac. A 0.16 GW pumped storage hydro unit at Green River is being considered. Information on transmission (Including the HVDC system), substations, and connection with Hydro Quebec is included.

32374 **Expansion of the role of the consulting engineer in the nuclear industry.** Fortier, P.C. (Canatom Ltd., Montreal, Quebec (Canada)). *Eng. J. (Montreal);* **59**: No. 5, 22-25(Sep 1976). (In French).

The role of Canadian engineering consulting firms in the design and construction of CANDU nuclear power plants at home and abroad, and in the design and construction of heavy water plants has increased in recent years. Generally, engineering consultants have a role to play in the design of the conventional part of a nuclear power plant rather than the nuclear part, which has hitherto been designed by Atomic Energy of Canada Limited, except that the Kanupp station at Karachi was designed by Canadian General Electric. The breakdown of a station into conventional and nuclear parts is explained in some detail. Canatom Limited forms part of a consortium which has managed the construction of Glace Bay Heavy Water Plant, and is managing that of La Prade.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 32126, 32334, 32551, 32586, 32587, 32588, 32589, 32590, 32591, 32592, 32593, 32594, 32595, 32596, 32597, 32600, 32601, 32603, 32604, 32628, 32631, 32633, 32636, 32637, 32638, 32639, 32640, 32641, 32642, 32643, 32644, 32645, 32646, 32647, 32648, 32649, 32650, 32651, 32663, 32667, 32671, 32835

32375 (ANL—76-113) **Three-dimensional thermal-neutron radiography.** Berger, H.; Reimann, K.J. (Argonne National Lab., Ill. (USA)). Oct 1976. Contract W-31-109-ENG-38. 24p. AT.

Three-dimensional radiographic methods provide a means of determining the depth of defect indications and minimizing the confusion that results from overlapping images of structures at various depths in an object. One method of obtaining and displaying three-dimensional radiographic images is multiple-film laminagraphy, i.e., a series of radiographic films taken at different orientations can be viewed superimposed to present a sharply focused image of any desired object plane. Methods that use multiple-film laminagraphy for three-dimensional thermal-neutron images are described. The thermal-neutron radiographic facility at the National Bureau of Standards Reactor was used to prepare sequential radiographs for each of several test objects to verify the three-dimensional capability of the approach. In previous gamma- and x-radiographic laminagraphy, the views at various angles were prepared by moving the source linearly and parallel to the film plane. In neutron radiography, however, the fixed nature of the neutron source and the relatively small size of the neutron beam makes rotation of the object-detector combination necessary. A rotation alone will produce a distorted image, since the linear magnification is a function of the angle of rotation. This is compensated for by a translation along the beam axis. The combined motion used in neutron laminagraphy has been demonstrated to be equivalent to the motion applied in x-ray laminagraphy. Radiographs were taken at 5° intervals, and up to nine films were combined for a laminagraphic view. One of the test objects used was a simulated fast-reactor fuel assembly that contained several defected rods at various depths in the component. The results can now be compared with previous gamma-ray laminagraphic work.

32376 (BLG—502) **Gas purification project. Annual progress report 1973.** Broothaerts, J.; Claes, J.; Collard, G.; Goossens, W.; Harnie, R.; Heylen, P.; Vaesen, J.; de Beukelaer, R.; Dubois, G.; Glibert, R. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jun 1975. 11p. NTIS (US Sales Only).

Conceptual and experimental studies on LMFBR reprocessing and reactor off-gas purification systems are summarized. Iodine sorption on zeolites, low-temperature adsorption of noble gases on charcoal and catalytic oxidation of hydrogen, simulating tritium, are being studied in laboratory set-ups. A pilot loop with 25 m^3h^{-1} throughput has been constructed. Results are quoted from the first phase of the iodine removal programme by scrubbing systems. Further extension of the test loop, comprising off-gases conditioning to removal of krypton in a cryodistillation unit, has been prepared. Delay-bed studies on ^{133}Xe extraction from LWR off-gases are reported.

32377 (CEA-CONF—3492) **Preliminary results of sodium boiling through a 19 heating rod bundle.** Menant, B. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1975. 17p. NTIS (US Sales Only) $3.50.

From 6. Meeting of the liquid metal boiling working group; Risley, UK (1 Oct 1975).

A test section including the GR.19 heating pin bundle has been designed in order to simulate a fast reactor sub-assembly. A first series of boiling experiments was performed with this text section on the CFNa II loop of the Service des Transferts Thermiques. Differences of temperature in the hottest section of the bundle were such that boiling was detected whereas the mean outlet temperature was more than 100 deg C below saturation. A study of the different aspects of undersaturated boiling was performed.

32378 (CEA-CONF—3493) **Permanent boiling in rod bundles: calculations with the FLICA II B code.** Menant, B. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1975. 11p. NTIS (US Sales Only) $3.50.

From 6. Meeting of the liquid metal boiling working group; Risley, UK (1 Oct 1975).

Some calculations have been made with the FLICA II B code using a model representing rod-bundles by means of few interconnected channels. The result obtained give some idea of the similarities and differences of behavior to be expected between single channels and rod bundles during permanent forced convection sodium boiling regimes. A new phenomenon, the so-called internal flow excursion is described.

32379 (COO—2245-32TR) **Thermal analysis methods for LMFBR wire wrapped bundles.** Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Nov 1976. Contract EY-76-S-02-2245.A001. 27p. Dep. NTIS $4.00.

A note is presented which was written to stimulate an awareness and discussion of the fundamental differences in the formulation of certain existing analysis codes for LMFBR wire wrap bundles. The contention of the note is that for those array types where data exists (one wire per pin, equal start angles), the ENERGY method results for coolant temperature under forced convection conditions provide benchmarks of reliability equal to the results of codes COBRA and TH1-3D.

32380 (FRNC-TH—645) **Automation and operation of a system of fuel element failure localization using the tracer method.** Argouarch, J. (Paris-11 Univ., 91 - Orsay (France)). 1976. vp. (In French). NTIS (US Sales Only).

The mass spectrometry unit installed in Phenix is part of the instrumentation for detecting and more especially localizing fuel element failures in the reactor. The technique of localization consists in introducing a small amount of a labelling gas (Xe, Kr) in every fuel pin during its fabrication. The labelling gas released from the failed pin, is recovered in the argon cover of the reactor through a continuous sampling. The sample previously enriched in Xe and Kr by chromatography, is analyzed in the mass spectrometer. The unit includes a Xe and Kr enrichment line followed by a vacuum unit for introducing the sample into the spectrometer, a quadrupole mass spectrometer, and a unit of data processing and automatic control of the whole. The automation of the system presents two different aspects: the mass spectrometer operation and protection, and the preparation of the samples to analyze. The automation functions are separately detailed: cabled automatisms for the mass spectrometer, cabled and programmed automatisms for the enrichment line control.

32381 (GEAP—13771-20) **Liquid metal fast breeder reactor program. Critical experiments and analysis twentieth quarterly report, July—September 1976.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Oct 1976. Contract E(04-3)-0893-TAS-5. 84p. AT.

Current activities and technical progress are reported for three subtasks. Subtask A covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Subtask B is directed towards the analysis of advanced fuels critical experiments that can provide a consistent data base for testing the computational tools, nuclear analysis techniques and basic nuclear data which are used in the LMFBR design effort, and for evaluating the nuclear performance and safety characteristics of advanced fuel materials. Subtask C is directed towards the development of LMFBR plant calculational methods that also can be used at the sites of the Clinch River Breeder Reactor to determine the reactor power distribution, reactivity and fuel status, and for consideration of alternative fuel and control management schemes.

32382 (HEDL-TC—25) **Sodium frost technology.** Funk, C.W. (ed.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1974. Contract EY-76-C-14-2170. vp. AT.

Included are nineteen chapters dealing with properties and effects of sodium deposits and aerosols in LMFBR cooling systems. Seven chapters were separately abstracted and indexed. (DG)

32383 (HEDL-TC—25, pp I.1-I.20) **Influence of sodium frost deposits on sodium cooled reactor systems.** Funk, C.W. Jul 1974.

In Sodium frost technology.

The paper reviews operational experience to establish the significance of sodium frost deposits on operation of sodium cooled reactor components. The original survey was limited to four domestic reactors, but because of availability of recent information, the review includes three foreign and four domestic reactors. The circumstances contributing to component malfunction attributable to frost or sodium deposits are reported, the conditions influencing the mechanism of frost deposition are identified, the impact of component malfunctions that could occur in sodium cooled reactor system is indicated, approaches for prevention of frost deposits are outlined, and remedial actions to overcome component malfunctions caused by frost are outlined.

32384 (HEDL-TC—25, pp IV.17-IV.27) **Condensing of sodium vapours from argon atmosphere.** Webster, J.M. (United Kingdom Atomic Energy Authority, Risley, Eng.). Jul 1974.

In Sodium frost technology.

The blanket gas in large fast reactor systems in which sodium surface temperatures are probably in excess of 400°C will contain an appreciable quantity of sodium. Recycling of blanket gas in order to supply a purge to equipment or a feed to a gas blanket fission product cleanup plant will necessitate a high degree of sodium removal. Since the vapor pressure of sodium falls sharply with decreasing temperature (three orders between 400°C and 200°C), condensation of sodium could in principle provide an effective method of removal. An important problem to be guarded against in a condenser for this purpose in that of fog formation since its generation in the unit could lead to practically the whole of the sodium load being carried through the condenser in this form. Argon is the favored gas for most blanket gas systems. The paper examines condensation of sodium from argon gas streams in the light of two theories for predicting fog formation in condenser coolers: the general tendency of a system to supersaturate on cooling and the phenomenon of boundary layer fog formation.

32385 (HEDL-TC—25, pp V.1-V.20) **Surface tension of liquid sodium and its wetting behaviour on nickel and stainless steels.** Todd, M.J.; Turner, S. Jul 1974.

In Sodium frost technology.

The surface tension and wetting characteristics of liquid sodium have been measured in a small pumped apparatus, in which the sodium could be continuously purified with respect to oxygen. Pure argon was used to blanket the free surface of sodium. The vertical plate (zero buoyancy) method of measuring the surface tension gave values in good agreement with recent published work. This method has the advantage that no precise knowledge of the sodium density is necessary. In experiments where the oxygen content of the sodium was changed, it was found that, over the temperature range 150 to 265°C, there were no significant differences between the surface tension of sodium containing nominally 5 ppM oxygen and sodium close to the solubility limit (10 to 80 ppM depending on the temperature). The wetting of nickel and stainless steel was found to depend a great deal on the cleaning process employed, as well as on the sodium temperature. Contamination of the sodium with oxygen accelerated the wetting of nickel but retarded that of the stainless steels. Possible reasons for this behavior are discussed and additional evidence is given, in the case of stainless steels, from rubbing experiments in liquid sodium.

32386 (HEDL-TC—25, pp VI.1-VI.6) **Characterization of the compounds Na_2O and NaOH in the Na-O-H system.** Block, F.E.; Henry, J.L. Jul 1974.

In Sodium frost technology.

Precise knowledge of the sodium-water reaction and reaction products is necessary for the development of methods of monitoring oxygen and hydrogen in sodium, for understanding tube wastage,

cold trapping, and other related topics. The reaction between sodium and sodium hydroxide in the temperature range 320° to 520°C is of fundamental importance in this connection. This reaction, which takes place when molten sodium and water come into contact, is a metathetical reaction involving four substances, Na, NaOH, Na_2O, and NaH. It is, in fact, a reciprocal ternary system. The understanding of this system is incomplete, and the products of this reaction have not been characterized. It is the objective of the program described to characterize the solid phases of NaOH and Na_2O in relation to the binary system NaOH-NA_2O, and the ternary system Na-O-H.

32387 (HEDL-TC—25, pp VII.1-VII.10) **Evaluation and control sodium aerosol problems.** Kessie, R.W.; Van Deventer, E.H. Jul 1974.

In Sodium frost technology.

The presence of sodium aerosol in the cover gas can create significant problems in reactor operations. Comparison of measured aerosol concentrations and calculated vapor concentrations indicates that aerosol concentrations can exceed maximum vapor concentrations by factors as large as nine. Preliminary measurements of the particle-size distribution of sodium aerosol in argon over sodium at 400°C have been made with a Casalla jet impactor. Measurements at lower temperatures were masked by a high blank in the sodium analysis and at higher temperatures were prevented by plugging of the outlet tube. These problems are expected to be overcome in future experiments.

32388 (HEDL-TC—25, pp XV.1-XV.14) **Heat transfer of sodium compounds deposited on surfaces from aerosols.** First, M.W.; Yusa, H. Jul 1974.

In Sodium frost technology.

Methods and apparatus have been developed to measure the coefficient of thermal conductivity of layers of elemental sodium combustion products deposited on heat exchange surfaces with an accuracy satisfactory for engineering design studies.

32389 (IKE—6-103) **Interpretation of experiments on the neutron flow in coolant lines of fast reactors. Combined Ssub(N)-Monte Carlo Albedo system for the efficient calculation of penetrations.** Bader, S. (Commission of the European Communities, Ispra (Italy). Joint Research Centre; Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Sep 1976. 102p. (In German). U PC A06/MF A01.

30 refs.; with figs. and tabs.

In this paper earlier experiments to study the neutron streaming in the penetration of the primary coolant circuit of a fast breeder are interpreted. The main components of the experimental arrangement were a source unit consisting of the thermal column of a reactor, a converter and a filter to generate a spectrum similar to that of fast breeder reactors, and the penetration proper, in which the penetration of a sodium-filled iron pipe with two rectangular bends through different walls of the shielding was realized. The measured values were interpreted in terms of the transport theory using the Ssub(N) programs ANISN and DOT, the Monte Carlo programme MORSE and a coupling of DOT and MORSE by means of the DOMINO program. The calculations show that the results of this model based on the analysis of the main processes can, in theory, be reproduced nearly everywhere within an experimental error of 20-40%.

32390 (INIS-mf—3311) **Annual Report 1975. Sodium technology development programme.** (Nijverheidsorganisatie TNO, The Hague (Netherlands). Projectgroep Kernenergie TNO). 1976. 20p. (In Dutch). NTIS (US Sales Only).

The Sodium technology development programme comprises a number of separate research programs in the field of designing and testing parts and components for the SNR-300 reactor. A designed cold trap is described and the results of research on hydrogen behaviour in sodium systems are reported. A test facility for sodium fire-fighting was made available and the first results of experiments are reported. In case of straight pipe or spiralized pipe steam generators, the results of research on hydraulics, vibrations, heat transfer, pressure drop and bubble dynamics are given. Experiments done on pump bearing development are reported briefly. Material research comprises corrosion and deposition, long duration effects and the mechanical properties of materials in sodium environments; results are described. The findings of research on welding and remote welding of sodium-wetted surfaces are given.

32391 (JAERI-M—6150) **Evaluation of tritium production by a sodium-cooled fast reactor.** Seki, Y.; Tanaka, K.; Sako, K. (Japan Atomic Energy Research Inst., Tokyo). Jun 1975. 18p. (In Japanese). TIC.

It is estimated that about 1-2 kg of tritium will be necessary for the initial inventory of experimental fusion reactor to be constructed in about 1990. The tritium requirement for subsequent operation of the experimental reactor and mock-up facility are several hundreds and several tens of grams each, respectively. The quantity of tritium produced by a sodium-cooled fast reactor of 100 MWth has been calculated by way of the neutronics. The production of over 100 g per year is possible by this small fast reactor.

32392 (KFK—1276/1) **Fast breeder project (PSB). First quarterly report 1976.** (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Jul 1976. 128p. (In German). NTIS.

With figs., tabs. and refs.

Activities performed during the 1st quarter of 1976 at or on behalf of the Gesellschaft fuer Kernforschung mbH, Karlsruhe, within the framework of the Fast Breeder Project are given a survey. The following project subdivisions are dealt with: Fuel rod development; materials testing and developments; corrosion studies and coolant analyses; physical experiments; reactor theory; safety of fast breeders; instrumentation and signal processing for core monitoring; effects on the environment; sodium technology tests; thermodynamic and fluid flow tests in gas.

32393 (KFK—2232, pp 78-89) **Computer program HERA.** Eifler, E.; Nijsing, R. (Commission of the European Communities, Ispra (Italy)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975).

6 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation ot the fuel-rod-mechanics.

The computer programme HERA is used for comparative calculation of temperature gradients in sodium-cooled fuel element clusters. It belongs to the group of computer programmes assuming the subchannels formed by the rods to be the smallest element of the flow diameter. The short description outlines the basic characteristics of this computer programme.

32394 (KFK—2232, pp 139-164) **Velocity gradients and pressure drop coefficients in fuel rod clusters.** Eifler, W. (Commission of the European Communities, Ispra (Italy)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975).

20 figs.; with refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

Possible simplifications of the mathematical procedure are discussed in connection with the discretization of the flow space in fuel rod clusters. The terms of momentum and mass balance for one element (laminar element, subchannel) are explained. The momentum balance is then applied to the two-dimensional flow state, while the momentum and mass balance together are applied to the three-dimensional flow state. Incoming and axial flows are then treated for one- and multi-channel systems.

32395 (KFK—2232, pp 21-37) **Status of the project SGR-fuel elements.** Goetzmann, K. (Kraftwerk Union A.G., Erlangen (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975).

3 figs.; 6 tabs.; 8 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

First of all, the advantages of helium-cooled fast breeders are pointed out, and the cooling system of the gas-cooled breeder is compared with that of other reactors. Another paragraph summarizes the state of the German work on the gas-cooled breeder. The design of the fuel elements of the gas-cooled breeder is explained, and construction data are given. The paper ends with a survey in tabular form of present and future development work on GCFR fuel elements.

32396 (KFK—2232, pp 39-70) **Results of comparative calculations of temperature gradients when cooling with sodium.** Hoffmann, H. (Kernforschungszentrum Karlsruhe (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975).

14 figs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

Advance calculations of temperature gradients, and pressure losses in fuel element clusters have been carried out in order to gain information on the applicability of existing computer codes by comparing the theoretical results with experimental values. In general, the comparison of precalculated and experimental pressure gradients yields satisfactory results. The comparison between precalculated and experimental temperatures shows: - The precalculated curves are generally consistent with the experimental results. - In nearly all of the cases, the precalculated values are higher than the experimental values. - The agreement between calculation and experiment increased with simpler cluster geometrie and increasing clarity of the thermo- and fluid-dynamic situation.

32397 (KFK—2232, pp 259-308) **Thermo-hydraulic behaviour of gas-cooled fuel elements.** Kraehe, A.R. (Societe Belge pour l'Industrie Nucleaire, Brussels). Mar 1975.

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 6 figs.; 1 tab.; 18 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

First of all, design data of a gas-cooled and a liquid-cooled fast breeder (1,250 MWe) are compared. The problem of mass flow redistribution is mentioned which occurs at low mass flow and low pressure of the reactor with helium as a coolant and roughened fuel rods. The influence of different swelling rates in claddings and spacers is studied, and a new type of spacer is proposed. Another chapter discusses the influence of tolerances on the mass flow redistribution.

32398 (KFK—2232, pp 5-19) **Status of the project SNR-fuel elements.** Mayer, H. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 8 figs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

The fuel elements for the initial charge of the SNR-300 is described, and their characteristic data are given. The state of planning and fabrication of the fuel elements and the organisation of the project SNR-300 are outlined. The boundary conditions of the design (system, technology, material) are dealt with, and the reasons for choosing the cluster concept are given. Further R + C activities to be carried out (development of methods, iradiation tests) and safety requirements are mentioned.

32399 (KFK—2232, pp 109-138) **Physical and mathematical modelling of rod bundle thermohydraulics.** Nijsing, R. (Commission of the European Communities, Ispra (Italy)). Mar 1975.

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 20 figs.; 8 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

Theoretical approaches to the calculation of the temperature distribution in fuel element clusters are derived. They are based on the model assumption of the flow around the fuel elements, the transport approaches for mass, momentum, and energy, and on the transport characteristics of turbulent flow. The diffusion and convective interaction coefficients are defined which determine the heat transport between neighbouring elements. The results are compared with experimental data.

32400 (KFK—2232, pp 203-228) **Heat removal in gas-cooled fuel rod clusters.** Rehme, K. (Kernforschungszentrum Karlsruhe (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 12 figs.; 22 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

For a thermo- and fluid-dynamic analysis of fuel rod cluster subchannels for gas-cooled breeder reactors, the following values must be verified: a) friction coefficient as flow parameter; b) Stanton number as heat transfer parameter; c) influence of spacers on friction coefficient and Stanton number; d) heat and mass exchange between subchannels with different temperatures. These parameters are established by combining results of single experiments and of integral experiments. Mention is made of further studies to be performed in order to determine the heat removal from gas-cooled fast breeder fuel elements.

32401 (KFK—2232, pp 231-254) **Influence of the temperature gradients in sodium-cooled fuel rod clusters on the design of fuel rods and clusters.** Seehafer, H.J. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 10 figs.; 2 tabs.; 1 ref.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

The article starts by pointing out the role of thermohydraulics in core design. Interactions between the thermohydraulic system and the design groups physics and fuel rod design are mentioned. The further text analyzes the demands made on the thermohydraulic system by the fuel rod design concerning the temperature distribution, i.e. the temperature gradient across the fuel rod and the maximum fuel can temperature. Stresses on the cladding tube (mechanical, thermal, chemical) are gone into, and the criteria for fuel rod design are derived from these considerations. Finally, the cluster layout is discussed.

32402 (KFK—2232, pp 167-200) **Temperature gradients of sodium-cooled fuel rod clusters.** Weinberg, D. (Kernforschungszentrum Karlsruhe (F.R. Germany)). Mar 1975. (In German).

From Seminar of the Fachgruppe Thermo- und Fluiddynamik der KTG im DAtF; Bensberg, F.R. Germany (11 Mar 1975). 12 figs.; 1 tab.; 43 refs.

In Thermo- and fluiddynamic subchannel-analysis of fast-breeder-fuel-elements and its relation to the fuel-rod-mechanics.

The latest Nusselt relations for the calculation of cladding tube surface temperatures in hexagonal clusters are presented. The problem of 'swirl flow' is mentioned. Preliminary results on turbulent heat flow in irregular geometries are given.

32403 (KFK—2312) **NEA coordinating group on gas-cooled fast reactor development. Annual progress report of the Federal Republic of Germany 1975.** Krug, W.; Krawczynski, S.; Dalle Donne, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Jul 1976. 12p. (Juel—1303; EUR—5502e). NTIS (US Sales Only).

1 tab.; 39 refs.

The paper gives a short summary of the work performed in the Federal Republic of Germany for the Gas Cooled Fast Reactor in the frame of the NEA-OECD Collaborative Programme on GCFR's. The work has been performed at the two German Nuclear Centers at Karlsruhe and Juelich. In the field of fuel element development, heat transfer experiments have been performed to improve the thermal performance of the artificial roughness on the fuel element pin surfaces, and preparations for a large irradiation experiment in the reactor BR2 are under way. In the field of design and safety studies the work was concentrated on the development of a computer code to investigate the dynamic behaviour of a GCFR with a steam turbine, on investigations of the cooling of the core melt caused by a core melt-down accident, on neutron streaming effect studies, and on calculations of the energe release by hypothetical scram rod ejection accident.

32404 (KFK—2313) **Experimental investigation of heat transfer in a bundle of 19 rods roughened by transverse rectangular ribs.** Rehme, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Aug 1976. 65p. (In German). NTIS (US Sales Only) $4.50.

34 figs.; 5 tabs.; 24 refs.

An experimental investigation was performed with respect to the pressure drop and the heat transfer of helium at pressures up to 42 bar flowing through a bundle of 19 tubes arranged in a hexagonal array. The tubes had a length of 2280 mm, the heated length was 1970 mm of which downstream a length of 750 mm was roughened by transverse rectangular ribs. The rods at a pitch-to-diameter ratio of P/D = 1.42 were contained in a hexagonal liner. The tubes (volumetrical O.D. 18.37 mm) were heated directly by direct current; the heating power was changed between 43 and 435 KW corresponding to a heat flux of 12 - 116 W/cm. The maximum wall temperature measured was 1,110 K (837°C). The experimental Reynolds numbers ranged from 1.16×10^3 to 1.19×10^5.

32405 (KFK-EXT—6/76-4) **Comparison of the computer codes FRUMP and SATURN-1.** Elbel, H.; Matthews, J.R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Jun 1976. 8p. INIS.

12 figs.; 2 tabs.; 10 refs.; with apps. Also publ. as AERE-M-2782.

The computer codes FRUMP and SATURN-1 simulate the behaviour of LMFBR fuel rods under conventional operational conditions. The evaluation of various irradiation experiments at the reactor CABRI (Cadarache) with these programmes led to differing results. This is the reason why a comparison was made on the basis of simplified operational conditions and uniform data. This revealed fundamental differences in the basic assumption of the two codes. In FRUMP geometry changes of the cracked fuel pellet refer to its symmetry axis, whereas in SATURN-1 the locus of centre of mass of coherent fuel segments is used as the reference point or line. The first case corresponds to the pellet maintaining its integrity although cracked and the second corresponds to independent motion of cracked pellet fragments.

32406 (LMEC—76-5) **Testing of L-100-4 linear induction EM pump. Final report.** Eichelberger, R.L. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 15 Dec 1976. Contract EY-76-C-03-0700. 190p. AT.

The report describes the testing of a linear induction electromagnetic sodium pump, type L-100-4, at the Liquid Metal Engineering Center. The pump, fabricated by Atomics International from a design by MSA Research Corporation, was tested in a sodium loop at temperatures from 400 to 1040°F (205 to 560°C). Hydraulic performance curves were obtained for operation in the forward and reverse directions and under conditions of reduced net positive suction head (NPSH). The pump was also exposed to thermal cycling and simulated emergency conditions.

32407 (PNC-N—943-75-05) **Local temperature rise due to a 6-channel blockage in a 7-pin bundle.** Daigo, Y.; Haga, K.; Ohtsubo, A.;

Kikuchi, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Sep 1975. 7p. NTIS (US Sales Only).

From 6. meeting on liquid metal boiling working group; Riseley, UK (1 Oct 1975).

An experimental study was performed of local temperature rises due to a non-heat-generating blockage in an electrically heated LMFBR 7-pin bundle. Each pin was 6.5 mm in diameter and had a 450 mm heated length. The pitch-to-diameter ratio (P/D) was 1.22. The bundle was inserted in a hexagonal duct. The central six channels in the bundle were blocked by a 0.5 mm thick stainless steel plate 350 mm downstream from the start of the heated section. The temperature distributions were measured by the thermocouples which were mostly located downstream from the blockage. The experimental conditions were as follows; Coolant velocity : 0.37 -- 5,00 m/s Linear heat rate : 8.5 -- 127.2 w/cm Inlet coolant temperature : 298 -- 296 °C. The hottest surface temperature of the central pin was observed immediately downstream from the blockage. The measured temperature rise was approximately two thirds of the predicted value by the LOCK code, in which the presence of a stagnation behind the blockage was assumed. When the experimental results are applied to reactor conditions, the temperature rise due to a 6-channel blockage is considered to be less than 130°C.

32408 (SRD-R—41, pp Paper no.SNI 3/17) **Applying methods of reliability analysis to the Rapsodie reactor.** Arlaud, J.C. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Div. d'Etudes et de Developpement des Reacteurs). Jan 1975. (In French).

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

The variation of failure rate (lambda) as a function of total running time of Rapsodie and also for each of the characteristic periods: operational at 24 MW for May 1967 to February 1970, and then at 37 MW (Fortissimo version) has been studied. In both cases classic bath tub curves are obtained without the characteristic climb due to wear. Failure rates during the period of useful life are practically 4.3 x 10^{-3} giving a MTBF of the order of 230 h. The duration of the teething trouble period of Rapsodie is distinctly longer than that of Fortissimo. These results have been obtained by counting only those unexpected incidents during operation of the reactor which brought about a variation in lower level. To classify these incidents a dimensionless number, A, is introduced. It is used to assign a relative acuity to failures of various components. This number should define the efforts required as a priority in order to improve Rapsodie performance.

32409 (TID—27313(Vol.A)) **ERDA-EPRI LMFBR Design Projects: Phase I, final report. Volume A. Project activities and major decisions.** (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.; Stone and Webster Engineering Corp., Boston, Mass. (USA)). Jul 1976. Contract EY-76-C-03-1141;EY-76-C-03-1146. 158p. AT.

An overview of the Prototype Large Breeder Reactor (PLBR) Project is presented. The project objective is to develop the design of an LMFBR power plant which will be licensable and be prototypical of subsequent breeder reactor plants. Project activities and major decisions made to date are discussed.

32410 (TID—27313(Vol.B)) **ERDA-EPRI LMFBR Design Projects: Phase I, final report. Volume B. PLBR design characteristics.** (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.; Stone and Webster Engineering Corp., Boston, Mass. (USA)). Jul 1976. Contract EY-76-C-03-1141;EY-76-C-03-1146. 272p. AT.

Design characteristics of the Prototype Large Breeder Reactor are presented. Chapters are included on general criteria and plant description, site characteristics, design criteria for structures and components, reactor design, heat transport systems, engineering safety features, instrumentation and control, electric power, auxiliary systems, steam and power conversion, radioactive waste management, manufacturing engineering, and cost estimates.

32411 (TID—27313(Vol.C)) **ERDA-EPRI LMFBR Design Projects: Phase I, final report. Volume C. PLBR research and development requirements.** (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.; Stone and Webster Engineering Corp., Boston, Mass. (USA)). Jul 1976. Contract EY-76-C-03-1141;EY-76-C-03-1146. 47p. AT.

Volume C contains twenty-seven research and development items that have been identified by the Westinghouse-Stone and Webster PLBR design team. These R and D programs have been prepared by the individual designers on the basis of the PLBR design as it is defined and described in the Phase I report. The volume has been assembled such that tasks of equal priority are grouped together, starting with those R and D requirements that are considered essential to the viability of the PLBR design as it presently stands. The "essential" category is further subdivided into two categories, "Urgent"—those programs which must be included in GFY77 funding plans, and "Required Later"—those which can be initiated later than GFY77. The second category, which is labeled "important" consists of those programs that would allow reduction in cost of the plant, refinement of the design, significant improvement in availability, but would not cause the design to become infeasible if they were eliminated. The "desirable" programs will improve the performance of the plant, simplify operation, or advance the state of the art. The tasks have also been grouped according to their subject, such as instrumentation, materials, etc. A matrix has been included such that cross references between the subject headings and priority headings may be made.

32412 (TID—27313(Vol.D)) **ERDA-EPRI LMFBR Design Projects: Phase I, final report. Volume D. Technical appendices (topical reports).** (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.; Stone and Webster Engineering Corp., Boston, Mass. (USA)). Jul 1976. Contract EY-76-C-03-1141;EY-76-C-03-1146. 520p. AT.

Volume D contains fourteen Topical Reports which discuss most of the key decisions and concept selections made for PLBR and CBR during Phase I. The decisions and concepts are reported throughout Volume A and B, but these Topical Reports provide additional technical detail and evaluations on which Westinghouse based its positions. The Topical Reports are referred to in the main body of the report as Appendices. Having been prepared by Westinghouse alone, they should not be considered part of the main report.

32413 (UJV-mf—1) **Seminar on measurement techniques.** (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). 1976. vp. (In Czech). (CONF-750383—). TIC.

From Seminar on measurement techniques; Prague, Czechoslovakia (25 Mar 1975).

Separate abstracts for individual papers are presented. (DCC)

32414 (UJV-mf—1, pp 251 p.) **Use of experimental techniques in selecting the optimum attack angle of the leading cone of a sodium loop sectional valve in a plane.** Nemecek, S. (Vysoka Skola Strojni a Textilni, Liberec (Czechoslovakia)). 1976. (In Czech).

From Seminar on measurement techniques; Prague, Czechoslovakia (25 Mar 1975).

Published in microfiche form. Available from Nuclear Information Centre, Praha-Zbraslav, Czechoslovakia.

In Seminar on measurement techniques.

The experimental testing of hydraulic conditions in the valve was conducted using four methods: the smoke channel, the air channel, hydraulic analogy, and the schlieren technique. The purpose of the work was to determine the optimal angle of the inner leading cone of the valve. The results showed that the 90deg angle was the most suitable.

32415 (UJV-mf—1, pp 251 p.) **Evaluation of the mixing effect of two non-isothermal streams by measurement of the resulting stream temperature profile.** Rocek, J. (Sigma, Prague (Czechoslovakia). Vyzkumny Ustav Cerpacich Zarizeni, Potrubi a Armatur). 1976. (In Czech).

From Seminar on measurement techniques sponsored by Special commitee for fast reactors fluid dynamics and heat transfer; Prague, Czechoslovakia (25 Mar 1975).

Published in microfiche form. Available from Nuclear Information Centre, Praha-Zbraslav, Czechoslovakia.

In Seminar on measurement techniques.

A measuring technique was elaborated and applied for evaluating the mixing effect of the sodium loop mixing chamber using modelling based on the measurement of the temperature profiles of two nonisothermal air streams. The respective similarity criteria were derived and the measuring apparatus described. The experimental results proved the designed mixing chamber to be unsuitable and led to the design of a new variant.

32416 (UJV-mf—1, pp 251 p.) **Operation experience with SE-Laboratories pressure transducers.** Cervenka, J.; Mantlik, F.; Hejna, J. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). 1976. (In Czech).

From Seminar on measurement techniques sponsored by Special committee for fast reactors fluid dynamics and heat transfer; Prague, Czechoslovakia (25 Mar 1975).

Published in microfiche form. Available from Nuclear Information Centre, Praha-Zbraslav, Czechoslovakia.

In Seminar on measurement techniques.

The results of operating tests and calibration experiments with pressure transducers of the SE 1150/WG type are compared with guaranteed values given by the manufacturer. The calibration method and apparatus used are described. A considerable zero

instability and changes in sensitivity and linearity with temperature were found. The experiments showed that pressure transducers of this type may be used for aerodynamic experiments only if they are placed in a suitable thermostat.

32417 (WAPD-TM—1131) **Decarburization of AM-350 stainless steel LWBR fuel rod support grids (LWBR development program).** Gourley, B.R. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Feb 1977. Contract EY-76-C-11-0014. 50p. Dep. NTIS $4.00.

A technique has been developed to controllably decarburize AM-350 stainless steel fuel rod support grids using a controlled frost point hydrogen atmosphere. Two processes have been extensively investigated: one in which the grid array is decarburized prior to brazing, and the other, in which the grid is decarburized after brazing. The latter process was ultimately selected as the core manufacturing process. The effect of carbon monoxide additions to control the decarburizing potential of the H_2—H_2O system was investigated. In addition, data are presented on the decarburizing potential of Ni—Cr—Si braze alloy in contact with AM-350 sheet material. Nitrogen losses to the furnace atmosphere during heat treatment and by absorption into the braze alloy are discussed. Decarburization data are presented for a large segment of the core grids to establish process capability.

32418 (WAPD-TM—1247) **Measurement of boron-10 lined and fission counter characteristics in an irradiated fuel environment (LWBR development program).** Stooksberry, R.W. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Jan 1977. Contract EY-76-C-11-0014. 14p. Refer all requests to DRDD.

Measurements near irradiated fuel rods were made to evaluate the performance characteristics of both boron-10 lined and fission counters in gamma flux typical of the fields to be encountered in this application during nondestructive irradiated fuel rod assay. Satisfactory operation has been demonstrated for the boron-10 lined and fission counters in respective gamma fields of 2400 and 12,000 R/hr.

32419 (WNICD—2381A46) **Sodium ionization leak detector. Final progress report for period ending June 30, 1976.** Lane, S.A. (Westinghouse Electric Corp., Hunt Valley, Md. (USA). Nuclear Instrumentation and Control Dept.). Jun 1976. Contract EY-76-C-02-2499. 63p. AT.

The Sodium Ionization Detector (SID) is under development as a small, sensitive sodium-to-gas leak detector for the LMFBR. Development work performed during the final year of a two-year Base Technology program is documented in the report. Included are results obtained in the following areas: (a) identification of improved filament materials, (b) continued filament life testing, (c) testing of chemical interferences upon sensor operation, (d) determination of gamma radiation interferences, (e) suppression of these radiation interferences by a compensation technique, (f) incorporation of readout electronic improvements, (g) continued field testing at LMEC, and (h) field testing at both the EBR-II reactor and the Westinghouse Research Laboratories. The test results and accomplishments during the year have confirmed the usefulness and sensitivity of the SID. However, further development work and testing, as well as some design improvements, are required to obtain an optimized, economic instrument which is completely qualified for plant use.

32420 Electro-magnetic valve for regulating a stream of molten metal. Robinson, T.S.; Linder, S.V. (to Aktiebolaget Atomenergi). Swedish Patent 388,257/B/. 27 Sep 1973. 10p. (In Swedish).

An electromagnetic valve for regulating a stream of molten metal is described. The valve comprises an outlet and members so arranged as to generate in the metal, in association with the outlet, electromagnetic forces tending to prevent the molten metal from flowing through the outlet. It is characterized by channels mounted in parallel at the outlet, the inlet or outlet of each of the channels being relatively small so that the influence of surface forces becomes considerable.

32421 Sub-assembly of nuclear reactor fuel elements. (to UKAEA). French Patent 2,281,630/A/. 8 Aug 1974. 6p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The sub-assembly of nuclear reactor fuel elements described comprises a cluster of clad fuel elements contained in an outer casing and spaced out from each other by helically wound fins of approximately uniform radial height and delimitating inner and outer groups of channels intended for allowing a cooling fluid to pass through the cluster. These fins are so placed as to make contact with the adjacent element claddings and thus form side bearings for these elements. The special feature of the sub-assembly is a metal filling wire running along each outer channel designed to allow the coolant to flow through and delimitated by a group of two outer fuel elements and by the casing. This undulated filling wire is fixed to the inner surface of the casing so as to provide bearing points located on several horizontal planes and intended for the fuel elements. This sub-assembly is designed for use in sodium cooled fast reactors.

32422 Sub-assembly of fuel elements for nuclear reactors. (to UKAEA). French Patent 2,281,632/A/. 8 Aug 1974. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The sub-assembly of nuclear reactor fuel elements described includes a cluster of fuel elements enclosed in an outer casing and spaced out from each other by spirally wound fins. The characteristic of this sub-assembly is that the height and pitch of the helically wound fins on the outer elements of the cluster equal half those of the fins spirally wound round the inner elements. At least one end of the outer elements is placed on a given polar and axial orientation so that the fins of the outer elements adjacent to the same cluster make contact. It is intended for sodium cooled fast reactors.

32423 System for cooling the upper wall of a nuclear reactor vessel. Pailla, H.; Schaller, K.; Vidard, M. (to CEA). French Patent 2,283,522/A/. 30 Aug 1974. 9p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

A system for cooling the upper wall of the main vessel of a fast neutron reactor is described. This vessel is suspended from an upper shield by the upper wall. It includes coils carrying a coolant which are immersed in an intermediate liquid bathing the wall and contained in a tank integral with the vessel. At least one of the two cooling and intermediate liquids is a liquid metal. The main vessel is contained in a safety vessel, the space between the main and safety vessels is occluded in its upper part by an insulating shield placed under the tank. There is a liquid metal seal between the upper wall and the upper shield under the tank. This system has been specially designed for sodium cooled fast neutron reactors.

32424 Structure for reducing the convection currents inside the vessel of a nuclear reactor. Benque, P. (Electricite de France, 75 - Paris); Lallement, J. (Groupement pour les Activities Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Lambert, P. (Alsthom, 75 - Paris (France)). (to CEA). French Patent 2,284,170/A/. 3 Sep 1974. 8p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The description is given of a structure for reducing the convection currents inside the vessel of a fast neutron reactor of the kind which comprises a core, inside a vessel, placed on a supporting structure and a second vessel located inside the first and surrounding the core. An annular space is provided between the outer surface of the core and the second vessel. The structure is formed of a hollow metal ring fixed by its lower part on the periphery of the supporting structure and located in the annular space. The walls of the ring are provided with holes. The width of the ring is less than that of the annular space and height is at least equal to that of the core.

32425 Fast neutron reactor. Kovin, V.M.; Mitenkov, F.M.; Ovechkin, A.V.; Pankratov, V.A.; Savin, N.I.; Ternikova, T.A. French Patent 2,284,954/A/. 16 Sep 1974. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The fast neutron reactor described includes a vessel filled with a liquid metal coolant in contact with an inert gas environment, which under the action of the forced circulation systems flows through whilst bathing the core and the tubes of the heat exchangers. The lateral surface of the vessel is a cylinder with its axis on a horizontal plane. It is fitted with pipes in which the liquid metal coolant enters into contact with the inert gas medium. The cross-section of the vessel is circular. The reactor includes an additional vessel in the shape of a tube fitted with a clearance inside the main vessel, the clearance between the two vessels allowing the coolant to flow in the direction of the heat exchangers towards the coolant forced circulation systems. The lateral surface of the vessel is stepped and one of the end steps has a smaller perimeter and is intended for fitting the forced circulation system for the coolant. The tubes of the heat exchangers are fitted parallel with the axis of the vessel. This reactor is provided with facilities for moving the core along the axis of the vessel.

32426 Process for protecting the cladding of nuclear fuel elements. Aubert, M.; Le Beuze, R. (to CEA). French Patent 2,285,681/A/. 20 Sep 1974. 5p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The process described is concerned with the protection of the internal surface of the stainless steel claddings of nuclear fuel elements against the corrosion action of mixed oxides and fission products. It is characterized by the fact that it consists in applying a metal coating to the inside surface of the cladding, the coating metal being choosen from manganese, molybdenum and chromium. The metal coating is applied to a thickness of between 5 and 100 microns by electrochemical deposition. The process applies in particular to the cladding of fuel elements for LMFBR type reactors.

32427 Studies needed to prevent the use of expansion bends in LMFBR intermediate heat exchangers. Kayser, G. (CEA Centre

d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides). pp 1-11 of In Structural mechanics in reactor technology. Vol. II. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The LMFBR IHX built in France consist in a vertical tube bundle welded on 2 tube sheets. The secondary sodium flows down a central pipe to the lower collector then up through the tube bundle where it is heated. The solution of the problems raised by the presence of thermal stresses needed thorough studies and led to the following theoretical and experimental developments: (1) A computer code was written for structural analysis. The structure was divided in annular elements that could be studied by means of the elementary theory of shells and plates; and reduced elastic coefficients were given to the tube sheets to account for the presence of drilled holes. (2) An experimental study was undertaken to determine the reduced elastic coefficients of the tube sheets. (3) A computer code was written to study the primary sodium flow around the tube bundle, and experimental studies were made on a mockup, the fluid being water. (4) The results of the previous code were used to determine, by means of a code for thermal analysis, the temperature field in the bundle both in steady state and transient regimes. Up to now, many transients were performed and the Phenix heat exchangers have been operating quite satisfactorily; this seems to prove the design assumptions were correct.

32428 Vibrational studies and measurements on the Phenix reactor. Tigeot, Y.; Livolant, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 1-9 of In Structural mechanics in reactor technology. Vol. II. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the sodium cooled fast reactors of pool type, the internal shells are relatively thin. Consequently since the beginning of the Phenix Project, a special attention has been devoted to the flow induced vibration of those shells. The main parts of the tests have been: tests on models; tests in air on the reactor shells with determination of the modal shapes and frequencies of the main components during the construction; measurements during the hot flow tests. The aim of these tests was to verify that the vibratory level of the different components was acceptable before the operation at full power, and for the future to check the theoretical and experimental methods used to predict and verify the vibrational levels in the sodium cooled reactors. The main results of all the tests are presented and analysed in the paper.

32429 70-MWt LMFBR steam generator test facility. Johanson, J.G.; Gimera, R.J. (Liquid Metal Engineering Center, Canoga Park, CA). *Am. Soc. Mech. Eng., [Pap.]*; No. 76-JPGC-NE-3, 1-9(1976).

The existing 35-MWt Sodium Components Test Installation (SCTI) is being upgraded to 70 MWt. The first test article in the upgraded facility will be the Clinch River Breeder Reactor (CRBR) prototype steam generator. This paper describes the upgraded facility design and test capabilities, the CRBR steam generator major design features, the test program for the steam generator, and the current status of design and construction of the facility.

32430 Oscillatory dryout related thermal stresses in clean steam generator tubes. Chu, C.L.; Wolf, S.; Dalcher, A.W. (GE, Sunnyvale, Calif). *Am. Soc. Mech. Eng., [Pap.]*; No. 76-JPGC-NE-2, 1-11(1976).

A two-dimensional finite element model is used to evaluate thermal stresses in clean (without oxide scale) steam tubes, induced by two different types of dryout point oscillation. The heat transfer coefficient transition from nucleate boiling to film boiling is modeled with a square wave form for the first type and a trapezoidal wave form for the second type. The oscillation with respect to the axial distance of the tube is sinusoidal for both types. The results of the analysis indicate that the dryout induced thermal stresses are sensitive to the characteristics of the axial variations of the dryout point and to the associated changes in oscillation frequency. 9 refs.

32431 Start of industrialisation of fast reactors in France. Dejou, A. (Electricite de France, 75 - Paris). pp 111-112 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976). (In French)

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

It was decided that power plants based on breeder reactors should be put into service in France as soon as possible. The reactors Rapsodie and Phenix were giving good results, but it now had to be decided what programme should be adopted to get to the industrial scale. Waiting too long for all possible results from the smaller reactors would lose time; so would a programme based on too many intermediate steps; but jumping too far at one step might introduce serious errors of extrapolation. The considerations leading to a 'Super-Phenix' are discussed. The cooperation between France, German Federal Republic and Italy in the fast reactor programme, by both government and industrial organisations, is described.

32432 Special sessions on breeding. 3 - panel on the role of breeders. Iliffe, M.C.E. (UKAEA Reactor Group, Risley); Morelle, J.; Rudzinski, K.; Vaughan, R.D.; Villeneuve, J.; Weinberg, A.; Wilson, R. pp 145-158 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

Chairman Dr. G. Schuster.

The conclusions of the two earlier panels on uranium availability and energy resources were summarized and it was noted that, if the O.E.C.D. energy programme included LWRs only, there would be a uranium shortage before the year 2000. The introduction of the FBR was therefore needed at an early stage. The panel discussed various aspects of the performance of breeders, such as plutonium inventory and doubling time. Technical and organizational problems of a breeder programme were also considered. In the concluding summary by the Chairman, Moderator and Panel there was a consensus on the need for the introduction of the fast breeder power reactor by 1985 to 90 and also for alternative breeders (such as the gas-cooled breeder reactor and molten salt reactor). World wide cooperation would be required to achieve this early result and also to perform the parallel developments in Pu fuel reprocessing, reactor safety, storage and shipping of plutonium, and in plant component reliability. A strong effort to achieve public acceptance was essential together with early standardization in safety and siting principles.

32433 Prospects of development of fast nuclear power reactors in the U.S.S.R. Meshkov, A.G.; Kazachkovsky, O.D.; Lytkin, V.B. (State Committee for Atomic Energy, Moscow (USSR) Physics and Power Institute). pp 120-124 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

Present nuclear power development in the U.S.S.R. as well as in other countries of the world is based on thermal power reactors. Fast breeder reactors will represent the second generation of power reactors, the primary objective of which is to ensure large scale development of the nuclear power system with minimum consumption of natural uranium. In the Soviet Union much attention is paid to the development and creation of commercial fast reactors. Nowadays the priority effort is on sodium-cooled fast breeder reactors, though some studies are being conducted on possible uses of gaseous coolants in fast reactors. For more than two decades, scientific and technical bases have been created for industrialization of sodium-cooled fast breeder reactors. The BR-5 reactor has already been working for 15 yr, the BOR-60 reactor for five years, the first large reactor BN-350 has been built and put into operation, and the construction of the BN-600 reactor has been practically completed, and mounting of the equipment is now going on. Design studies of the BN-1500 reactor are being conducted. Not all the problems of the creation of economically competitive and reliable fast breeder reactor power plants have been solved up to now. Some work remains to be done on advancing the design and increasing the equipment reliability of steam-generators in the first place, and on improving structural and fuel materials as well as on improving the processes of the fuel cycle.

32434 Commercial exploitation of fast reactors in the United Kingdom. Moore, R.V. (UKAEA Reactor Group, Risley). pp 108-110 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The basis for the fast reactor programme in the UK is stated, and the experience with DFR is outlined. The role of PFR in preparing for commercial fast reactors is summarized. Fuels and fuel fabrication and fuel reprocessing, are discussed. Plans for CFR 1 (Commercial Fast Reactor) are discussed, and environmental and safety aspects (siting and radioactive waste management) are considered.

32435 United States of America fast breeder reactor program. Nemzek, T.A. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). pp 95-107 of In Nuclear energy maturity. Vol. II. Zsleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The reasons for the development of the fast breeder reactor in the United States are outlined, and the LMFBR program is discussed in detail, under the following headings: program objectives, reactor physics, fuel and materials development, fuel recycle, safety, compo-

nents, plant experience program (Near Commercial Breeder Reactor). The special facilities to be used at each stage of the program are described. It is planned that the Near Commercial Breeder Reactor will be complete in 1986, and commercial plants should follow in rapid succession. An alternate fast reactor concept (Gas Cooled Fast Reactor) is outlined. The Environmental Impact Statement for the proposed program is summarized, and the cost benefit analysis supplied as part of the Environment Statement is also summarized.

32436 Passage to the industrial and commercial phase of the fast breeder reactors in Italy. Pierantoni, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). pp 113-115 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The agreements between Italy and France in the field of fast reactors are described with particular reference to PEC and Super Phenix. Between government and industrial organizations all aspects of the design and construction of fast reactors are covered including fuel fabrication. The relation of the Italian programme of LWR power reactors to the cooperative fast reactor programme is discussed. The urgency of the fast reactor programme for the Italian economy is stressed.

32437 Debenelux fast reactor programme. Traube, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). pp 116-119 of In Nuclear energy maturity. Vol. II. Zaleski, P. (ed.). Oxford; Pergamon (1976).

From European nuclear conference on nuclear energy maturity; Paris, France (21 Apr 1975).

The combined FBR programme of Germany, Belgium and Holland is described. Details are given of the progression in design from KNK through SNR 300 to the 1200 to 2000 MW(e) demonstration plant and of the fuel element developments. The organisational arrangements involving agreements between government and industry in research development and construction are described in some detail. Cooperation with third parties (Italy, Japan, UK and USA) is also outlined.

32438 Application of temperature fluctuation to anomaly detection in fuel assemblies. Tsunoda, T. (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Kanagawa. Nuclear Research Lab.). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 3, 103-110(Mar 1976).

Experiments on reactor malfunction diagnosis were conducted with an out-of-pile water loop with effective use made of subassembly outlet thermocouples. On-line measurements were carried out on temperature fluctuation amplitude, as well as on the average temperature. Experimental results revealed that the temperature fluctuation amplitude depends on the difference between the temperatures at channel inlet and at the point of observation and that monitoring of the temperature fluctuations should serve well for detecting of flow reduction and/or local hot spot in the fuel assemblies. The temperature fluctuation is also shown to serve effectively as indicator for measuring the transit time of fluid flow. Preliminary estimations on the temperature fluctuation amplitude made for the LMFBR indicate that the fluctuation amplitude should serve amply for effectively detecting anomalies in the fast breeder fuel assembly.

32439 Fuel cycle cost analysis on molten-salt reactors. Shimazu, Y. (California Univ., Berkeley (USA). Dept. of Nuclear Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 4, 190-198(Apr 1976).

An evaluation is made of the fuel cycle costs for molten-salt reactors (MSR's), developed at Oak Ridge National Laboratory. Eight combinations of conditions affecting fuel cycle costs are compared, covering ^{233}U-Th, ^{235}U-Th and ^{239}Pu-Th fuels, with and without on-site continuous fuel reprocessing. The resulting fuel cycle costs range from 0.61 to 1.18 mill/kWh. A discussion is also given on the practicability of these fuel cycles. The calculations indicate that somewhat lower fuel cycle costs can be expected from reactor operation in converter mode on ^{235}U make-up with fuel reprocessed in batches every 10 years to avoid fission product precipitation, than from operation as ^{233}U-Th breeder with continuous reprocessing.

32440 Bets on Superphenix. Gruhier, F. *Sci. Avenir;* No. 352, 540-544(Jun 1976). (In French).

Superphenix, extrapolation of Phenix and intermediate stage towards large breeder stations, is presented. The safety problems due to the presence of enormous quantities of sodium and plutonium are also reported.

32441 Device for remote inspection and testing of a structure. Blanc, B.; Boudou, J.; Castaing, A.; Clasquin, J.; Gallet, B.; Saglio, R.; Samoel, A. (to Commissariat a l'Energie Atomique). US Patent 3,987,666. 26 Oct 1976. Priority date 10 Apr 1974, France. 12p.

A self-propelled carriage for inspecting the primary vessel of a fast reactor is capable of displacement within the interspace between the primary vessel and the containment vessel in order to inspect and test any predetermined zone of the primary vessel, the carriage being associated with a drive mechanism and applied against the oppositely facing wall of the containment vessel. The carriage is suspended from a composite cable actuated by a handling apparatus for introducing the carriage into the interspace and withdrawing it therefrom. The composite cable supplies electric power as well as the different fluids required for positioning and operation of the inspection devices which are mounted on the carriage. 9 claims, 6 drawing figures.

32442 Process and apparatus for extraction of gases produced during operation of a fused-salt nuclear reactor. Blum, J.; Marie, J. (to Pechiney Ugine Kuhlmann). US Patent 3,993,542. 23 Nov 1976. Priority date 28 Feb 1974, France. 6p.

The present invention relates to the field of fused-salt nuclear reactors and its object is the extraction of the gases produced in the course of operation of these reactors. The process according to the invention consists in placing into position a piece of material permeable for gases and impermeable for the used fused salts, for instance, a piece of graphite, in such a way that part of the surface of this piece is in contact with the circuit of the radioactive salts and another part connected to a gas suction device. The piece could also be scavenged in its mass by a flow of inert gas. Application is contemplated in reactors using a mixture of lithium fluoride, beryllium fluoride, and uranium and/or thorium fluoride. 10 claims, 2 drawing figures.

32443 International cooperation will benefit the development of advanced reactors. Vendryes, G. (CEA, 75 - Paris (France)). *Nucl. Eng. Int.;* **21**: No. 251, 60-64(Dec 1976).

The present position and future prospects for fast breeder reactors and HTRs and associated developments in international cooperation is outlined. In summarizing the operating experience on Phenix, problems with heat exchanger leaks are described.

32444 Breeder reactor: a fossil fuel veiwpoint. Merrick, D. (Coal Research Establishment, near Cheltenham (U.K.)). *Nature (London);* **264**: No. 5587, 596-598(16 Dec 1976).

The concept of the fast breeder reactor is first briefly discussed, and this is followed by consideration of economic and technical factors that will make the reactor a viable option. It is stated that justification for the breeder reactor is essentially long term and that no clear economic advantage is likely until uranium prices have risen three to six times their present level. The impact of coal conversion processes is considered.

32445 Nuclear reactors. To breed or not to breed. A Pugwash debate on fast breeder reactors held at the Royal Society, London, on 28 September 1976 under the chairmanship of Sir Alec Merrison. Rotblat, J. (ed.). London; Taylor and Francis (1977). 124p.

The debate which is reported was timed to coincide with the publication of the Report of the (UK) Royal Commission on Environmental Pollution: 'Nuclear Power and Environment'. The volume comprises an introductory section, a report of an address by the Chairman of the Royal Commission and invited papers on fast breeder reactors in relation to energy requirements, on the safety of a commercial fast reactor, on processing and reprocessing of fuel, on radioactive waste management, and on diversion of plutonium and proliferation of nuclear weapons. An edited version of the discussion is presented under the following heads: comments on the report of the Royal Commission; projections of future energy requirement; thermal pollution; safety and insurance of reactors; reprocessing of fuel; storage and disposal of wastes; energy from fusion; utilization of coal; and proliferation of weapons and diversion of plutonium. Separate abstracts have been prepared for the six invited papers.

32446 Fast breeder reactors in relation to energy requirements. Chapter 2.1. The fast breeder reactor - some points for discussion. Walker, J. (Birmingham Univ. (UK)). pp 37-45 of In Nuclear reactors. To breed or not to breed. Rotblat, J. (ed.). London; Taylor and Francis (1977).

Particular aspects of the problems were illustrated by reference to diagrams, as follows: the critical situation of oil and natural gas as shown by block diagrams of world reserves and estimated consumption over the period 1973 to 1998; the UK fuel consumption 1950 to 1975, showing how oil and natural gas have grown in importance in relation to coal; the primary fuels and their uses in the UK in 1973 (showing proportions used in various ways, and proportion lost as rejected heat); and a forecast of UK primary energy sources up to 1990. Nuclear energy and other possible replacements for the primary fuels are considered.

32447 Fast breeder reactors in relation to energy requirements. Chapter 2.2. The energy case for the fast breeder reactor. Wright, J.K. (Central Electricity Generating Board, London (UK)). pp 46-58 of In Nuclear reactors. To breed or not to breed. Rotblat, J. (ed.). London; Taylor and Francis (1977).

It is shown that the world is going to need substantial quantities of energy from new sources early in the next century. Although it may be possible to get a significant amount from solar

and geothermal sources, it is far too early to predict how large a contribution they will be able to make. Nuclear power can make a large contribution and it would be wrong to do anything to close this option at this stage. Although there is considerable uncertainty about the precise quantity of commercially exploitable uranium in the world, it is almost certain that breeder reactors will be required. The time-scale is such that utilities throughout the world will need to be able to order breeders in quantity with complete confidence for operation from the mid 1990s onwards. The engineering, safety and logistic problems that are considered in the other chapters of this book are such that, if we are to meet this time-scale, we must press ahead with the utmost urgency.

32448 Nuclear fuel handling apparatus. Andrea, C.; Dupen, C.F.G.; Noyes, R.C. (to Combustion Engineering, Inc.). US Patent 4,002,529. 11 Jan 1977. Filed date 2 Jan 1974. 20p.

A fuel handling machine for a liquid metal cooled nuclear reactor in which a retractable handling tube and gripper are lowered into the reactor to withdraw a spent fuel assembly into the handling tube. The handling tube containing the fuel assembly immersed in liquid sodium is then withdrawn completely from the reactor into the outer barrel of the handling machine. The machine is then used to transport the spent fuel assembly directly to a remotely located decay tank. The fuel handling machine includes a decay heat removal system which continuously removes heat from the interior of the handling tube and which is capable of operating at its full cooling capacity at all times. The handling tube is supported in the machine from an articulated joint which enables it to readily align itself with the correct position in the core. An emergency sodium supply is carried directly by the machine to provide make up in the event of a loss of sodium from the handling tube during transport to the decay tank. 5 claims, 32 drawing figures.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 32669

32449 (AED-Conf—74-570-000, pp 151-166) **In-service testing of reactor pressure vessels in accordance with the requirements made by the authorities.** Gutmann, G. (Krautkraemer (Dr. J. u. H.) Gesellschaft fuer Elektrophysik, Koeln (F.R. Germany)). 1974. (In German).

From VGB conference on materials and welding in power plants - VGB materials conference; Duesseldorf, F.R. Germany (26 Nov 1974).

2 figs.; 2 tabs. Available from ZAED.

In VGB conference on materials and welding in power plants 1974 - VGB materials conference 1974. Papers.

The RSK guidelines for PWR reactors were issued in the protocol of the 93rd session of the RSK on April 24th, 1974. Similar RSK guidelines for BWR reactors will probably be published in autumn 1974. The article deals with the RSK guidelines only inasmuch as they apply to in-service testing.

32450 (NUREG/PRDI—76/12/P1) **Power Reactor Docket Information. Annual cumulation (citations).** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Dec 1976. 496p. TIC $17.25.

The 1976 annual cumulation of citations to the documentation associated with civilian nuclear power plants is presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by docket number in accession number sequence. The table of contents is arranged both by docket number and by nuclear power plant name. (DG)

32451 (NUREG/PRDI—76/12/P2) **Power Reactor Docket Information. Annual cumulation (subject index).** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Dec 1976. 449p. TIC $17.25.

Subject indexing to the documentation associated with civilian nuclear power plants is presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses.

32452 Philosophical goals of nuclear regulation. Muntzing, L.M. (LeBoeuf, Lamb and MacRae, Washington DC, USA). *Nucl. Law Bull.;* No. 17, 35-45(Apr 1976). (In English and French).

The idea that the federal authorities should play a major role in controlling nuclear activities so as to protect the public interest has ruled peaceful nuclear power development in the United States from the start. To defend public interest in a new and complex field such as the nuclear one is a difficult undertaking requiring a specialized and independent authority. This is why development and control of nuclear power, once assigned to the former Atomic Energy Commission (USAEC) have been separated, and the control function is now exercised by the Nuclear Regulatory Commission (NRC). The guidelines governing the present concept of regulation of nuclear activities are efficiency, - i.e. reducing licensing delays, cautions - particularly regarding radiation protection and safety standards, openness - public access to official documents, and finally, adaptability - evolution of regulations in step with technological developments and public requirements.

32453 Quality assurance system for nuclear power plant design and realization. Vaujour, J.A. (Electricite de France, 75 - Paris. Service Controle des Fabrications). *Tech. Mod.;* **68**: No. 7, 23-27(Jul 1976). (In French).

The organization set up by Electricite de France to ensure the quality control during the fabrication of nuclear power plant components is described.

32454 Legal regulation for nuclear exports. *Technol.-Nachr. Manage.-Inf.;* No. 202, 3-5(Nov 1976). (In German).

In order to cope with the uncertainties in the field of exports of nuclear technologies and facilities, a list of the legal regulations and international agreements is presented. These are based above all on the nuclear energy list of the 'Aussenwirtschaftsgesetz' (foreign trade law) and on international agreements concluded on the level of the IAEA.

32455 Paris thinks little of nuclear power moratorium. France wants to secure its sovereignty. *Handelsblatt;* No. 207, 13(Nov 1976). (In German).

'Moratorium no, stronger measures yes' - with this short slogan the French let their attitude be known to the USA with regard to its suggestions of an agreement between the main countries supplying nuclear power stations and nuclear technology, about their future nulear export policies.

ECONOMICS

REFER ALSO TO CITATION(S) 32484, 32723

32456 (AED-Conf—75-769-010) **Extension planning for electrical energy supply systems.** Bieselt, R. (Babcock - Brown Boveri Reaktor G.m.b.H., Mannheim (Germany, F.R.)). 1975. 16p. (CONF-7509129—124). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

13 figs.; 2 tabs.; 6 refs.

In the future as well as in the past, and in particular in the next decade a considerable increase in electrical energy demand can be expected. To satisfy this demand in a reliable and sufficient manner will force the utilities to invest large sums of money for the operation and the extension of power generation and distribution plants. The size of these investments justifies the search for more and more comprehensive and at the same time more detailed planning methods. With the help of system analysis a planning model for the electricity supply industry of a major supply area will be designed.

32457 (AED-Conf—75-769-012) **Economic bid evaluation.** Bode, T. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 62p. (CONF-7509129—125). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

With tabs.

When it is intended to install a new nuclear power station, the usual procedure is to invite for tenders. In due course, bids will be received from various manufacturers, out of which the most favourable one is then to be selected. Appraisal is concluded in the Economic Bid Evaluation, the purpose of which is to define the economically most favourable bid by comparing overall costs and benefits of the various alternatives. Thus, Economic Bid Evaluation is a most important instrument for deciding on award of contract.

32458 (AED-Conf—75-769-014) **General aspects of the project organization - the suppliers' view.** Bogen, J. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). 1975. 25p. (CONF-7509129—126). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

14 figs.; 6 refs.

One of the major aims in the economic management of a nuclear power project is the completion of the project on scheduled time, at predetermined cost and technical performance in accordance with pre-established goals. The achievement of these goals depends, to the major extent, on the adequacy and accuracy of the project plan. The highest possibilities to save money, minimize delivery time, secure good performance are given during the periode of project planning. During project implementation the project man-

agement only should direct activities for the realization of the pre-elaborated project plan.

32459 (AED-Conf—75-769-023) **General consideration of domestic participation in nuclear power projects.** Csik, B.J. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Power and Reactors). 1975. 10p. (CONF-7509129—127). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

No nuclear power plant can be supplied entirely by outside sources. Some degree of domestic participation is always required and this can be increased if desired. There is no general rule as to what can and should be supplied locally; different countries have different characteristics, conditions and possibilities, and these define the scope of what is to be done.

32460 (AED-Conf—75-769-028) **Turn key contracts.** Feretic, D. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 12p. (CONF-7509129—128). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

The aim of this summary is to point out some specific areas which have to be covered in a turn-key contract and which are of primary interest to the buyer of a nuclear plant. It will be assumed that the buyer is a utility company in a developing country and a plant supplier a company in an industrial country.

32461 (AED-Conf—75-769-061) **Tendering specification and contracting.** von Koch, E. (Kraftwerk Union A.G., Offenbach (Germany, F.R.)). 1975. 32p. (CONF-7509129—122). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

The lecture tendering, specification and contracting is prepared in two parts: This first part deals with technical aspects while part two features the commercial and legal situation in the partnership of two: the supplier of the fuel bundles and the utility. In this lecture a look is given on the way how a supplier can offer its fuel and some certain points are mentioned which are important to compare the bid of one competitor to the other. The major points are summarized which are or at least should be in an offer so as to find out which offer is the best.

32462 (AED-Conf—75-769-076) **General aspects of nuclear power plants' purchase.** Langetepe, G. (Badenwerk A.G., Karlsruhe (Germany, F.R.)). 1975. 24p. (CONF-7509129—129). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

Considerations and points of view which must be considered during the tendering and contracting of a nuclear power plant are presented.

32463 (AED-Conf—75-769-078) **Contract types - turnkey.** Loeffler, G. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 6p. (CONF-7509129—123). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

Turnkey or the turnkey type of contract refers to a system of management according to which one organization accepts total responsibility for completing all parts and all phases of a project. In the case of a power project the turnkey contractor undertakes to design the plant, supply or procure and erect the equipment, build the station and put it into operation.

32464 (AED-Conf—75-769-079) **Contract - introduction.** Loeffler, G. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 14p. (CONF-7509129—130). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

1 fig.

The contract is the last and final step of project planning and the first step of project implementation. The contract has to specify in detail and to the point, as concisely as possible, the complete scope of supplies and work, define all technical particulars and requirements, put forward the conditions of legal, regulatory, administrative and financial procedure, prepare for operating and maintenance instructions to be issued after commissioning. In short, the contract is expected to be a reliable instrument during the manufacturing and construction period as well as a guide-book to assist the owner afterwards in the operation and maintenance of the plant.

32465 (AED-Conf—75-769-092) **Contract types for nuclear power projects, non-turnkey type contracts in particular.** Nyte'n, T. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 10p. (CONF-7509129—131). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

6 figs.; 1 tab.

A non-turnkey contract differs from a turnkey contract in no special formal way. The way the buyer chooses to exercise his project leadership must be concretized in the contract. The way and extent he wishes to exercise technical checking must be laid down in the form of clear rules. The way information has to flow from one contractor over buyer to others and vice versa has to be laid down in detail and the consequences of non conformance fixed in such a manner that optimum project performance is reached.

32466 (AED-Conf—75-769-098) **Load description for WASP.** Roberts, J.T. (International Atomic Energy Agency, Vienna (Austria)). 1975. 2p. (CONF-7509129—132). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

5 figs.

Description of the LOADSY module of the IAEA WASP computer code used in power planning studies.

32467 (AED-Conf—75-769-105) **Nuclear power investment and generating costs from a utility point of view.** Roth, B.F. (Badenwerk A.G., Karlsruhe (Germany, F.R.)). 1975. 34p. (CONF-7509129—133). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

11 figs.

Nuclear power stations presently in operation in the Federal Republic of Germany have electricity generating costs between 3.5 Pf/kWh and 4.5 Pf/kWh. The higher electricity generating costs are due mainly to the increased expenditure required for the protection of plants against airplane crashes, earthquakes and sabotage, and to the higher costs of the entire fuel cycle.

32468 (AED-Conf—75-769-125) **Non-turnkey contract.** Shimoyama, S. (Japan Atomic Power Co., Tokyo). 1975. 8p. (CONF-7509129—134). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

1 tab.

A turnkey contract is recommended to such a country which is in the initial stage of nuclear power development with respect to a few plants being constructed earlier. The prime contractor may not necessarily be a reactor supplier. In some cases an architect engineering company may be a contractor. If this arrangement is not possible and the contract had to be a non-turnkey type, there might be some advantage to such a developing country capable of undertaking some major portions of the project works. Even if she might face troubles and difficulties during construction of the first nuclear power station, she might have a chance of aquiring technical kowledge and experience which would later enable her to make the plant of her own manufacture. In such a case it is advisable to limit the number of main contracts as small as possible and to utilize an organization to assist the owner in project management or to assume this function in his behalf.

32469 (AED-Conf—75-769-126) **Sources of supply for nuclear power plants.** Skjoeldebrand, R. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1975. 10p. (CONF-7509129—135). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

3 tabs.

In a competitive commercial market situation, such as the one which now exists for nuclear power plants, it is necessary for each prospective buyer to make his own judgements as regards the risks and benefits, advantages and disadvantages of the different suppliers. These judgements should be based on factual data and on some firm criteria supplemented by considerations stemming from the local situation. It is the purpose of this paper to discuss these criteria and considerations and how they can be applied to the data basis.

32470 (BMFT-FB-K—76-03) **Future demand in electrical power and meeting this demand, in particular with the aid of nuclear energy.** (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Jul 1976. vp. (In German). NTIS (US Sales Only) $16.25.

With figs., tabs. and refs.

As a part of the research program in question, the study deals with meeting the electrical power demand in the FRG until the year 2000 in the best possible way with regard to costs, and evaluating the long-term technical, ecological, and economical effects resulting thereof. With the aid of a model, the construction of additional plants and the use of the FRG's power plant network, always applying economical criteria, are investigated while allowing for adequate assurance of supply. It becomes obvious that the power plants and fuels available influence a 25-year planning period. In the year 2000, nuclear energy will play a dominating role in meeting the demand, the conventional thermal power plants will be used more for coping with the above-average medium loads, while peak loads will be met, above all, by pump storage stations.

32471 Updating of the Agency's Market Survey and recent power planning studies. Goodman, E.I. (International Atomic Energy Agency, Vienna (Austria)). *At. Energy Rev.;* **14**: No. 3, 567-578(1976).

Since the publication in 1973 of the Agency's Market Survey of the economic potential of nuclear power in developing countries, additional studies have continued to predict more realistically this aspect of electrical growth. An updating was prepared in 1974 to reflect the precipitous increase in crude oil prices. Actual forecasts in studies of individual countries are continuing, based on more extensive analysis and the latest economic factors. These studies have been performed for Pakistan, Bangladesh, Indonesia and Hong Kong. A new forecast is presented for certain developing countries in Africa, America and Asia, which gives a range of 250-400 GW(e) of nuclear capacity installed by the end of this century. The lower forecast is considered most likely and represents approximately 30% of the total installed electrical capacity of these countries.

32472 Nuclear power planning study for Indonesia (Java Island). Vienna; IAEA (1976). 208p.

The major objective of the study is to determine the optimum timing and size of nuclear size of nuclear power plants that could be built on Java Island during the period 1978-1997. The study could also be considered as a general survey of the available energy resources in the country. Included are economic background, rational energy resources, electricity supply system on Java Island, forecast of electric energy demand, methodology and basis for evaluation, frequency stability analysis and results of analysis. In 8 appendixes technical, economic and financial aspects of the demand for electrical energy are discussed.

32473 Nuklearpolitik in Westeuropa und die Forschungspolitik der Euratom. (Nuclear policy in Western Europe and the research policy of EURATOM). Kramer, H. Koeln, Germany, F.R.; Heymanns (1976). 256p. (In German).

7 tabs.; with refs.

The author makes an attempt to work out the most important factors which have influenced the development of a common policy in the peaceful utilization of nuclear energy and were instrumental in the change of the ambitions of the EURATOM-agreement and of the foundation period to a pragmatic action in the sphere of a reasonable compromise. He arrives at the conclusion that the attempt to establish the industrial potential of Western Europe in the nuclear section within the frame of the community by developing a common research policy is finished and has failed. Literally he sais: 'Neither has a serious common research policy taken place, nor were the development and the strengthening of the Western-European nuclear industry influenced by the activities of EURATOM.' (HP).

32474 Energy demand and the role of nuclear power. Kadela, J. *Elektrotech. Obz.;* **65**: No. 6, 358-359(Jun 1976). (In Czech).

The development of total costs and of the individual cost items is discussed of 1kWh of electric power in newly built conventional electric power plants and in nuclear power plants in the years 1972-1975. The cummulated need of natural uranium up to the year 2030 for the whole world (excluding the socialist countries) is given.

32475 Possible contribution by electrical energy to the improvement of European energy balances. Laigroz, J. (Electricite de France, 75 - Paris); van den Damme, R. (Societe Intercommunale Belge de Gaz et d'Electricite, Brussels, Belgium). *Elektrizitaetsverwertung;* **51**: No. 9, 198-206(Sep 1976). (In French).

Discusses recent changes in Europe in the consumption of primary energy sources and in the use of electrical power for various applications. The technical, economical and political justification for the increase in nuclear power generation and the relative technical and economical competitiveness of electricity and primary fuels are considered. It is concluded that in the first half of the next decade about 3/4 of the electrical power will be generated in nuclear power stations and that at the turn of the century electrical energy is likely to account for 2/3 to 3/4 of the total energy consumption.

32476 Nuclear power generation. Hill, J. (UKAEA). *Atom (London);* No. 241, 292-296(Nov 1976).

From Annual meeting of the British Association for the Advancement of Science; Lancaster, UK (3 Sep 1976).

The case for nuclear power, from both a world and a British standpoint, is first discussed, with particular reference to oil supply and demand. It is considered that oil and gas should in future be used as a feedstock for the chemical industry, for transportation purposes, and as a starting point for protein food for animals and later for humans; to squander so much by burning simply as a crude fuel cannot be right. It is considered that Britain should continue constructing nuclear stations at a steady modest rate, and that the fast reactor should receive increasing attention, despite the anti-nuclear lobby. The case for the fast breeder reactor is discussed in detail, including its development at UKAEA Harwell and Dounreay. Accusations against the fast reactor are considered, particularly those concerned with safety, and with the use or misuse of Pu. Public debates are discussed.

32477 Nuclear energy debate. Rippon, S. *Electron. Power;* **22**: No. 11, p. 759-760(Nov 1976).

With reference to the public discussion which is taking place at the moment concerning the future of nuclear energy in the UK, the document from the Advisory Council on Research and Development for Fuel and Power and also the report of the Royal Commission on Environmental Pollution are considered. Although there have been many other projections of UK and world energy requirements prepared by many different organisations, few cover such a wide range of scenarios in such detail as the ACORD report. The Royal Commission report contains many reassuring findings on the more extreme claims of the worldwide anti-nuclear movement, but one cannot read it without gaining the impression that the nuclear option is the energy source they would most like to do without. It is felt that against this background, it would seem to be time for the power industry to stop defending nuclear energy as an acceptable necessity and rather promoting it as the best energy option.

32478 New nuclear energy structures in France. *Atomwirtsch., Atomtech.;* **21**: No. 11, 518-519(Nov 1976). (In German).

1 fig.

For everybody working in the field of nuclear energy in France, the restructuring and reorganisation of this sector has been of major importance. Reorganisation affected both the CEA and the nuclear industry and had significant effects on the relation between state and industry.

32479 Energy research in the UK. Marshall, W. (Department of Energy, London (UK)). *Atom (London);* No. 242, 302-313(Dec 1976).

Unwin memorial lecture to the British nuclear energy society at the Institution of Civil Engineers 28 Sep 1976.

The wide range of energy research projects that should be considered, and the strategy to be employed, including the problem of how to assess the R and D needs of particular technologies are first discussed. The time scale considered is from the near future to the next 50 years. An assessment is made of the contribution and overall importance of coal, oil, natural gas, and nuclear energy, and the detailed attention is given to research in the fields of coal mining technology, in situ coal conversion, oil and natural gas production, and nuclear power generation. In connection with the last named, nuclear fuel processing, including the production of Pu-bearing fuel and the development of the fast breeder reactor, receive emphasis. The expanded fuel reprocessing plant at Windscale is briefly discussed, including radioactive waste management. British thermal reactor policy is discussed, involving the AGR, SGHWR, and LWR. Mention is made of the development of the gas centrifuge method for U enrichment, and the problems of fusion power are briefly reviewed, including the JET. Other energy means considered include extraction of energy from the winds, waves and tides, solar radiation, and geothermal sources. It is considered that whilst these alternative energy sources could, as a group, make a useful contribution to future requirements, they cannot, on any reasonable time scale, make a contribution even approaching the significance of coal or nuclear power. Energy conservation and distribution technologies receive attention, as also does energy conservation.

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 32747

32480 (SRD-R—41, pp Paper no.SNI 3/26) **Statistical analysis of the behaviour of the mechanical equipment of EDFs power plants - evaluation of the availability and safety of thermal and nuclear units.** Procaccia, H.; Brillon, A.; Cravero, M.; Lucenet, G. (Electricite de France, 93 - Saint-Denis. Service Generateurs et Echangeurs de Chaleur Thermiques). Jan 1975. (In French).

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of eliability techniques to nuclear plant.

The investigation and research directorate of EDF has undertaken a statistical analysis of the behaviour of large mechanical equipment at conventional power stations during the ten years following the operating reports of these stations. It has thus been possible to determine the intrinsic reliability, the failure rate, the mean repair time, and the mean good operating time of feed water reheating points, power turbines, pumps and boilers of the various EDF plants (125 and 250 MW) leading to a consideration of the feasibility of an extrapolation to present and future plants. Based on these elementary investigation two methods of calculation have been developed. One is used to assess the overall availability of a thermal or nuclear power station based on the knowledge of the failure rates of the equipment, each piece of equipment being associated with an idea of its technical importance in the functioning of the equipment. A numerical application is given for 125 and 250 MW conventional plants. The purpose of the other method is to estimate the operational safety of the safety equipment of nuclear power stations, based on the development of tree diagrams for faults in basic equipment. A numerical example is given for the cooling systems for Phenix and for one of the Super Phenix versions.

FUEL CYCLE

REFER ALSO TO CITATION(S) 32064, 32106, 32128, 32439

32481 (AED-Conf—75-769-080) **Financial aspects of the nuclear fuel cycle.** Lurf, G. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). 1975. 9p. (CONF-7509129—137). TIC.

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

2 figs.; 2 tabs.

A nuclear power plant has a forward supply of several years as a consequence of the long processing time of the uranium from mining to delivery of fabricated fuel elements and of the long insertion time in the reactor. This leads to a considerable capital requirement although the specific fuel costs for nuclear fuel are considerably lower then for a conventional power plant and present only 15% of the total generating costs.

32482 (AED-Conf—75-769-081) **Nuclear fuel financing.** Lurf, G. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). 1975. 10p. (CONF-7509129—136). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

3 figs.

Fuel financing is only at its beginning. A logical way of developing financing model is a step by step method starting with the financing of pre-payments. The second step will be financing of natural uranium and enrichment services to the point where the finished fuel elements are delivered to the reactor operator. The third step should be the financing of fuel elements during the time the elements are inserted in the reactor.

32483 (IEA-TI—44) **Thorium utilization: conversion ratio and fuel needs in thermal reactors.** Oosterkamp, W.J. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Engenharia Nuclear). Mar 1975. 9p. (In Portuguese). NTIS (US Sales Only).

As a preparatory study for thorium utilization in thermal reactors a study has been made of the fuel consumption in existing reactor types. A quantitative description is given of the influence of enrichment, burnup, amount of structural material, choise of coolant and control requirements on the convertion ratio. The enrichment is an important factor and a low fuel comsumption can be achieved by increasing the enrichment.

PROCESS HEAT REACTORS

32484 (CEA-CONF—3543) **Nuclear desalination.** Huyghe, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1975. 22p. (In French). INIS.

From International congress on energy and petrochemistry; Teheran, Iran (5 May 1975).

The use of small or medium size nuclear reactors for the desalination of sea water has gained economic interest since the increase of oil prices. These reactors, with a wide range of power from 135 to 1,100Mwth, are parrticularly interesting because their production of fresh water or electricity is tailored to the present need. The replacement of conventional fuel boilers by nuclear reactor boilers does not change the traditional desalination technology and alters very little the coupling of the electricity and water producing parts of the plant. It is a reasonable assumption that the performance of desalination plants will increase with the optimization of the design technology of a mixed plant. The cost of the water produced in a mixed plant is mainly related to local conditions and to the method of splitting the cost between water and electricity. It is therefore impossible to give in this paper a cost for the fresh water production.

NUCLEAR REACTOR TECHNOLOGY

32485 (INIS-mf—3346) **Summary of activities July 1975-July 1976.** (Stichting Reactor Centrum Nederland, The Hague). 1976. 20p. U PC A02/MF A01.

List of scientific publications.

The covered period of the RCN activities is from July 1, 1975 to June 30, 1976, but financial figures are given for the calendar year 1975. Each section gives the background against the work of RCN. The sections are: organization, nuclear power stations, the nuclear fuel cycle, the DeBeNeLux project, helium cooled reactors, thermonuclear reactors, non-nuclear energy, utilization of the Petten Research Reactors, environmental research and external relations. A list of RCN-publications is included in this short status report on nuclear energy in the Netherlands. The developments in the energy sector are having far-reaching consequences for RCN. This is expressed in the new name Stichting Energieonderzoek Centrum Nederland (ECN), Netherlands Energy Research Foundation ECN. The Energy Study Centre will be accommodated within ECN, which also will be given responsibility for various national energy research programs.

32486 **Nuclear reactor.** Motoda, H. (to Hitachi, Ltd.). US Patent 3,986,924. 19 Oct 1976. Priority date 1 Oct 1971, Japan. 8p.

A nuclear reactor is described in which fissionable material is placed as fuel in the reactor core in such a manner as to provide the most effective utilization of the material, wherein a fuel assembly is divided into three concentric regions around the core center and is loaded with fuel in such a way that if, for convenience, the regions are named the first region, second region and third region, respectively, in the order of distance from the core center, the infinite multiplication factors in these regions will be such that the factor in the third region is smaller than that in the first region and that in the first region is smaller than that in the second region.

THEORY AND CALCULATION

32487 (FEI—526) **Generalization of experimental data on water heat transfer in staggered rod bundles.** Ushakov, P.A.; Zhukov, A.V.; Titov, P.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1974. 21p. (In Russian). NTIS (US Sales Only).

8 refs.; 3 tables.

On the basis of experimental results of heat transfer to water from chess-positioned rod bundles with a different relative pitch, the effect of the Nu number change versus the relative pitch of the fuel element lattice is observed, provided the hydraulic diameter be used as a characteristic linear size to estimate the Nu number. Data on the heat entrance section length are given for the bundles studied. Results available in the USSR and abroad for heat transfer studies of fuel bundles with a large lattice pitch are systematized. An empirical formula is recommended for the Nu number calculation for rod bundles in a wide range of relative pitch, Re and Pr number changes.

32488 (IAEA—186, pp 113-137) **Importance of transactinide nuclear data for the physics of fast and thermal reactor cores.** Barre, J.Y.; Bouchard, J. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). 1976.

From Advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

Translated from French.

In Transactinium isotope nuclear data (TND). Vol. I.

The importance of transactinium isotope nuclear data in the physics of fast and thermal reactors relating directly to core parameters and to fuel composition calculations is reviewed. The influence of transactinides on reactivity loss and internal breeding gain and power in fast reactors is analysed. The accuracies required in transactinide nuclear data for core parameter calculations, and the sensitivity of the isotopic compositions of fast reactor fuel due to variations in transactinide cross sections are evaluated. Specific nuclear data accuracies are recommended.

32489 (IAEA—186, pp 139-166) **Transactinium isotope build-up and decay in reactor fuel and related sensitivities to cross section changes.** Kuesters, H.; Lalovic, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). 1976.

From Advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

In Transactinium isotope nuclear data (TND). Vol. I.

The importance of nuclear data for the assessment of transactinium isotope build-up and decay in typical thermal and fast reactors is presented. Consideration is given to associated hazards from radioactive materials during shipping, reprocessing and waste storage. The effect of nuclear data uncertainties on the prediction of transactinium isotope formation and on the level of radioactivity after shutdown is evaluated. Results of transactinium isotope nuclear data sensitivity studies, performed with the ORIGEN code for typical 1000 MWe LWRs, HTGRs and a 2000 MWe LMFBR, are presented.

32490 (IAEA—186, pp 167-173) **Requirements for transactinium nuclear data for the design and operation of nuclear power plants.** Nunn, R.M. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). 1976.

From Advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

In Transactinium isotope nuclear data (TND). Vol. I.

This review is concerned with the importance of transactinium nuclear data to reactor designers and operators, solely in the context of actinides as emitters of radiation. Their importance in the physics design of reactor cores and in criticality aspects of fuel storage and handling is covered in review A2. Here we are concerned with their importance in shielding, access, maintenance, heat removal, instrumentation and fuel handling and storage.

32491 (INDC(CCP)—66/U, pp 22) **Monte Carlo calculations of a reactor cell in the resolved-resonance region.** Naumov, V.A.; Rogozin, S.G.; Ehl'perin, T.I.; Kozhinov, A.G. Feb 1976.

Translated from Russian. Published in summary form only.

In Nuclear physics research in the USSR. Collected abstracts. Issue 20.

32492 (UJV—3779-R) **Calculations of a "standard" reactor using ABBN constants.** Tinka, I. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). May 1976. 15p. (In Russian). U PC A02/MF A01.

For a fast sodium-cooled reactor fuelled by UO_2 -PuO_2 a ksub(eff) calculation was performed in three variants. The tables compare the constants used by the Nuclear Research Institute in Rez and by the Institute for Physics and Power in Obninsk.

32493 (ZJE—172) **Power reactors operational diagnosis.** Dach, K.; Pecinka, L. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1976. 24p. U PC A02/MF A01.

The definition of reactor operational diagnostics is presented and the fundamental trends of research are determined. The possible sources of power reactor malfunctions, the methods of defect detection, the data evaluation and the analysis of the results are discussed in detail. In view of scarcity of a theoretical basis and of insufficient in-core instrumentation, operational diagnostics cannot be as yet incorporated in a computer-aided reactor control system.

32494 **Successive linearization method in optimization problems in nuclear reactor operation.** Khromov, V.V.; Kashutin, A.A. *At. Energ. (USSR);* **39**: No. 5, 359(Nov 1975). (In Russian).

Deposited article; for English translation see the journal Sov. J. At. Energy.

32495 **Nuclear reactor flux calculations by the source-sink (heterogeneous) method.** Ferguson, A.F.; Dwight, J.R. (Central Electricity Generating Board, London (UK). Computing Dept.). pp 261-267 of In Computational methods in classical and quantum physics. Hooper, M.B. (ed.) (Strathclyde Univ., Glasgow (UK)). London; Advance Publications Ltd (1976).

From 3. national computational physics conference; Glasgow, UK (27 Aug 1975).

The procedure described calculates the neutron flux distribution in heterogeneous reactors in two or three dimensions. The subject is covered in sections entitled: equations (moderator (two dimensions, three dimensions, dipoles); channels; eigenvalue problem); solution (structure; symmetry; iterative solution (eigenvalue, inner iterations, gradient method, block iteration, stopping)); power shaping; program; ADOS package.

32496 **New parameter of reactor noise.** Kishida, K.; Sekiya, T. (Osaka Univ., Suita (Japan). Dept. of Nuclear Engineering). *Atomkernenergie;* **29**: No. 1, 1-8(1977).

5 figs.; 10 refs.

A new formalism for the analysis of reactor noise is proposed from a viewpoint of non-equilibrium statistical physics for open systems. A new parameter α representing the irreversible circulation in a space of state variables is introduced using the system size expansion method. Here we show that α is, together with the variance, a useful integral index of power spectral density, and particularly that α is closely related to the asymmetry of correlation functions among state variables. The α is useful for information processing of reactor noise, especially in reactor stability analysis. The validity of the assumption of the 'normal' case is also examined.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 32542, 32678, 32805, 32834, 32872

32497 (AECL—5310, pp 11-14) **Fundamental studies of steam generator and heat exchanger tube fretting.** Ko, P.L. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Feb 1976.

In AECL research and development in engineering, winter 1975.

High flow rates in steam generators and heat exchangers of nuclear power reactors tend to create flow-induced vibration. Fretting is the result of tube vibration which makes the tube impact and rub on supporting devices or adjacent tubes causing local damage.

32498 (AECL—5310) **AECL research and development in engineering, winter 1975.** (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Feb 1976. vp. NTIS (US Sales Only).

Separate abstracts are included for individual papers. (DCC)

32499 (CEA-N—1857(ed.2)) **Nuclear electronic equipment for control and monitoring panel. Specifications and methods for testing radiation detectors.** Roguin, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). Feb 1976. 56p. (In French). (CEA-S-MCH-MENT—5). NTIS (US Sales Only).

This document will be of interest to users and makers of neutron and gamma radiations detectors in the field of nuclear reactor control and protection. Information is given which will enable users to optimize their choice and methods of using equipment, and makers to optimize their methods of fabrication. It should also serve as a model from which official specifications, technical instructions and test methods for these detectors, could be established. A detailed description is given of the appropriate parameters, terminology and notations. General specifications, operating conditions and test methods are indicated. The following detectors are studied: in-core detectors: fission ionization chambers, self powered neutron detectors (S.P.N.D.); out-core detectors: boron ionization chambers (for monitoring), boron trifluoride proportional counter tubes, boron lined proportional counter tubes, helium-3 proportional counter tubes. The devices described in the document are intended for industrial radiation monitoring applications and not for calibration standards (dosimetry) or for health physics measurement purposes. They are characterized by their fidelity, fast response, reliability and long lifetimes.

32500 (CEA-R—4765) **Failure detection in power stations. Application to nuclear reactors.** Blanc, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique; Bordeaux-1 Univ., 33 (France)). Jul 1976. 180p. (In French). INIS.

The development and application of a technique for the automatic diagnosis system of a nuclear power station is presented. The aim of this study is to design a computerized system to detect a malfunction in the core of a nuclear power plant. After a review of anomaly detection methods, a diagnosis method based upon internal representation is chosen. This method is characterized by the use of a physical modeling of the nuclear core. A systematical investigation is achieved in order to retain the convenient structure of the mathematical model. A digital simulation of several identification algorithms is performed to obtain the most efficient one. An on-line identification method using sensitivity equations and generalized recursive least squares technique is developed. The diagnosis of a malfunction is obtained by comparing in real time the reference parameters value corresponding to a normal functioning to the actual value of an on-line identification scheme. An on-line computerized system, able to detect incipient failures, is designed. Applications, using real data, are given to demonstrate the efficiency of the proposed technique.

32501 (CEA-R—4769) **Automatic digital ratemeter with constant accuracy and correction of dead time.** Gauthier, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). Jul 1976. 111p. (In French). NTIS (US Sales Only).

After an analysis of analog and digital linear ratemeters and the comparison of their performances, an automatic digital ratemeter with constant accuracy and correction of dead time was developed. The ratemeter automatism consits in the adjustement of the counting time according to the counting rate to maintain a minimal stochastic error, over a wide range of measurements. However, if the apparatus

is mounted in a neutron measurement unit including a detector with a dead time implicating counting losses, it is necessary to correct the results of the measure accordingly. This correction is performed by a micro-calculator which, taking into account the dead time value displayed by the operator, calculates the true value of the counting rate after each cycle of the ratemeter measurement.

32502 (EUR—5473) **Theoretical aspects of the EURDYN computer programs for non-linear transient dynamic analysis of structural components.** Donea, J.; Giuliani, S.; Halleux, J.P. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). May 1976. 66p. NTIS (US Sales Only).

The computer programs EURDYN for nonlinear transient dynamic analysis of two- and three-dimensional structures, is described. Non-linearity arises from large displacements as well as from elastic-plastic material behavior. The finite-element displacement method is used and the equations of motion are formulated in terms of convected co-ordinates that rotate but do not deform with the elements. A lumped-explicit scheme is used to advance the solution in time. The finite-element library of EURDYN/1 includes the constant-strain triangle (plane or axisymmetric), a recti-linear beam element and a conical shell element. EURDYN/2 employs isoparametric elements for plane stress, plane strain and axisymmetric situations. EURDYN/3 deals with thin shells in three-dimensional space.

32503 (FRNC-CONF—156) **Study of the cold sources of Paluel, Gravelines, Port-la-Nouvelle, and Dampierre power plants.** Di-Crescenzo, B. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). 1975. 24p. (In French). (CONF-7510143—16). INIS.

From Cycle of lectures on the cold sources of electric power plants; Royaumont, France (6 Oct 1975).

For the same heat release 1kWth nuclear requires an amount of cooling water 60% higher than for a conventional kWth, in the same time the power installed on a site grows from 2400MWe (Porcheville plant) up to 3700MWe or 5400MWe such as at Dampierre or Paluel. This evolution increases the problems posed by the design and construction of the cooling circuit works in the same time as it seems to be an incentive to seaside plants or inland plants with cooling systems. Besides, a new cooling function of the reactor auxiliaries especially involving the nuclear safety with its specified requirements, is added to the conventional cooling function of the condenser. For the first seaside type of plant, another series of differences is seen: Paluel is a cliff site taking from and rejecting the water in the high seas, when Port-la-Nouvelle is on a plane untidal sandy coast, and Gravelines on a tidal seaport site. As for the second type of plant, Dampierre uses a closed circuit for the condenser cooling and an open circuit for the reactor auxiliary cooling systems.

32504 (FRNC-CONF—160) **Cold source economic study.** Fuster, S. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). 1975. 26p. (In French). (CONF-7510143—18). INIS.

From Cycle of lectures on the cold sources of electric power plants; Royaumont, France (6 Oct 1975).

This computer code is intended for the statement of the general economic balance resulting from using a given cold source. The balance includes the investments needed for constructing the various materials, and also production balances resulting from their utilization. The case of either using an open circuit condenser on sea or river, or using air cooling systems with closed circuits or as auxiliaries can be dealt with. The program can be used to optimize the characteristics of the various parts of the cold source. The performance of the various materials can be evaluated for a given situation from using very full, precise economic balances, these materials can also be classified according to their possible uses, the outer constraints being taken into account (limits for heat disposal into rivers or seas, water temperature, air temperature). Technical choices whose economic consequences are important have been such clarified.

32505 (ORNL—5173) **Review of analysis methods for prestressed concrete reactor vessels.** Dodge, W.G.; Bazant, Z.P.; Gallagher, R.H. (Oak Ridge National Lab., Tenn. (USA)). Feb 1977. Contract W-7405-ENG-26. 106p. Dep. NTIS $5.00.

Theoretical and practical aspects of analytical models and numerical procedures for detailed analysis of prestressed concrete reactor vessels are reviewed. Constitutive models and numerical algorithms for time-dependent and nonlinear response of concrete and various methods for modeling crack propagation are discussed. Published comparisons between experimental and theoretical results are used to assess the accuracy of these analytical methods.

32506 (SRD-R—41, pp Paper no.SNI 3/8) **Reliability techniques covering the operational conditions of reactor systems.** Blombach, J.; Rosenhauer, W.; Zeibig, H. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plants.

Reliability methods which have been developed and tested for reactor systems are described. The importance of operational conditions, which are not covered by the standard reliability model, is discussed using as examples a reactor power supply system, and a condensate pump system. The reliability techniques which are discussed include analytical methods and, for more complex conditions, Monte Carlo simulation using a computer program.

32507 (SRD-R—41, pp Paper no.SNI 3/6) **Reliability analysis - a systematic approach based on limited data.** Bourne, B.J. (UKAEA Systems Reliability Service, Risley). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques on nuclear plant.

The initial approaches required for reliability analysis are outlined. These approaches highlight the system boundaries, examine the conditions under which the system is required to operate and define the overall performance requirements. The discussion is illustrated by a simple example of an automatic protective system for a nuclear reactor. It is then shown how the initial approach leads to a method of defining the system, establishing performance parameters of interest and determining the general form of reliability models to be used. The overall system model and the availability of reliability data at the system level are next examined. An iterative process is then described whereby the reliability model and data requirements are systematically refined at progressively lower hierarchic levels of the system.

32508 (SRD-R—41, pp Paper no.SNI 3/12) **Optimal design of a system containing mixed redundancies with respect to reliability and cost.** Misra, K.B. (Technische Univ. Muenchen (Germany, F.R.)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A nuclear system generally consists of subsystems that may employ any of the partial, standby, and active redundancies, and is, therefore, a system with mixed type of redundancies. Optimization of reliability or availability of such systems at the design stage is a difficult problem. There appears to be no published work on the optimal design of maintained systems consisting of mixed redundancies. An attempt is therefore made, to present the basis of design and the solution technique to achieve this. An algorithm is described which makes the solution of this mathematically difficult problem possible. Some examples are demonstrated. To achieve further efficiency a study was organized and the recommendations for obtaining a minimum solution time are provided. Although, in the illustration, only the linear constraints and reliability, as the only design parameter, have been considered, the algorithm works well with the nonlinear type of constraints and can be used with other design parameters also.

32509 (TREE-NUREG—1007) **Thermocouple correlation transit time flowmeter tests at WCL.** Lassahn, G.D. (EG and G Idaho, Inc., Idaho Falls (USA)). Nov 1976. Contract EY-76-C-07-1570. 47p. Dep. NTIS $4.50.

Scoping tests indicate the feasibility for using transit time flowmeters with thermocouple sensors in steam-water steady state flow. Conclusive results were not obtained. More conclusive results are expected from tests to be conducted in the semiscale facility with a redesigned transit time thermocouple sensor.

32510 **Failed fuel element monitor.** Tamanov, E.A.; Odinokov, V.I.; Batenin, I.V.; Zolotukha, Yu.S. USSR Patent 411,522. 15 Jan 1974. 2p. (In Russian).

Filed 13 Dec 1971.

The installation described is for carrying out control upon the airtightness of fuel element jackets. It comprises an endurance chamber, a collecting electrode, a high-voltage electrode, a drive mechanism, a detector, a feeding system and a branch for the controlled gas. To eliminate neutral aerosols sorption on the collecting elec-

trode, the body of the installation is accomplished with an opening for blowing through the clean gas; the opening is positioned on the side where the controlled gas entrance is. The clean gas flux forms a barrier to the neutral particles, whereas the ionized particles can overcome this barrier, being under the effect of the electrostatic field and precipitate on the collecting electrode.

32511 Propagation and damping of acoustical waves inside ducts with flow effect of section discontinuities. Guerin, B.; Lesueur, C. (Institut National des Sciences Appliquees (INSA), 69 - Villeurbanne (France)); Baylac, G. (Electricite de France, 78 - Chatou. Direction des Etudes et Recherches). pp 1-12 of In Structural mechanics in reactor technology. Vol. II. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A good measurement of fluctuating processes, the evaluation of damages in reactors, the design of systems for lowering response, require the knowledge of mechanical and acoustical transfer functions. The present work deals with propagation of plane waves inside ducts with flow; waves are assumed to have their origin out of the studied portion; the junction between ducts is made by sudden (or continuous) section change. The purpose is to separate the effect of discontinuity from the other factors acting on propagation and more precisely on damping of acoustical waves (upstream and downstream boundary conditions, viscosity, wall stiffness constant).

32512 Three-dimensional analysis of cracked concrete in prestressed concrete pressure vessels and comparison with experimental results. Hansson, V.; Stoever, R. (Bochum Univ. (Germany, F.R.)). pp 1-12 of In Structural mechanics in reactor technology. Vol. III. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A calculation procedure describing local crack development is discussed. This procedure is based on the dynamic relaxation method. The relaxation method can be used with advantage if alterations of the system and nonlinear material behaviour as for instance for the bond characteristics of different types of reinforcement bars have to be considered. The computer program allows to divide a cracked zone progressively into substructures for which boundary conditions along cracks and at the connection with the structure are prescribed. The reinforcement is desribed as bars, and in accordance to deformation differences and non-linear bond-slip characteristics equivalent at the bars and in the structure. Crack development for characteristic tensile stress states in pressure vessels has been calculated. For instance calculations for tensile zones caused by temperature changes show that the instationary growth of a tensile zone combined with stresses resulting from prestress may be of greater influence on the crack width than a reinforcement. Measurement with the 1:5 model of the THTR are performed to determine crack development under certain loadings.

32513 Stress analysis of liners for prestressed concrete reactor pressure vessels with regard to non-linear behaviour of liner material and of anchor-characteristics. Oberpichler, R.; Schnellenbach, G. (Engineering Society Prof. Zerna-Dr. Schnellenbach, Bochum, Germany); Weber, R. (Steinmueller (L.u.C.) G.m.b.H., Gummersbach (Germany, F.R.)). pp 1-17 of In Structural mechanics in reactor technology. Vol. III. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The thin liner attached by anchors like a membrane to the interior wall of a prestressed concrete reactor pressure vessel (PCRV) has to provide the leak-tightness of the vessel. Furthermore the liner may serve as internal shuttering for placing of concrete as well as a support for the cooling system. The two-dimensional behaviour of the liner is investigated with regard to non-linear anchor-characteristics and non-linear material behaviour of the liner. The analysis is based on a plane stress model under the assumption of a membrane state of the liner. Calculations are performed by the dynamic relaxation method. With the aid of available non-linear stress-strain diagrams, describing the post-buckling behaviour, individual panels are considered as buckled ones. The adjacent unbuckled panels are calculated on other non-linear diagrams. Strains and stresses in the liner and additional shear loads in the anchors can be calculated with arbitrary sizing and spacing of the anchors. With respect to the parameters they are easily controlled. Since actual loads on the liner are defined by the PCRV-behaviour, an economical and safe design is possible. Finally an extreme case is calculated to assess the maximum value of the shear-forces assuming zero post-buckling capacity for the buckled panel.

32514 Modular internal circulation filter for nuclear reactors. Mayers, J.B.; Desmarchais, W.E.; Shallenberger, J.M. (to Westinghouse Electric Corp.). French Patent 2,280,178/A/. 24 Apr 1975. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 20 May 1974, US.

The installation described is for removing possibly harmful debris in a nuclear reactor during pre-commissioning tests. It includes a pressure vessel, a coolant intake and outlet allowing for a flow to circulate through it. An upper core plate and a lower core plate maintained at a given distance apart in the vessel are provided with apertures for coolant flow. An upper structure is fitted near the top of the pressure vessel. Numerous filtering systems containing filtering elements are placed on this lower core plate together with stud bolts spaced out for fitting fuel elements. At least one stud housing opening is made in each filtering system in order to orientate these systems accurately on the core plate and each filtering system comprises facilities for positioning, in a removable way, each filtering system on this plate. These facilities are so designed as to enable each system to be removed when the pre-commissioning tests are terminated. These filtering units are effectively able to trap swarf and filings that may have inadvertently remained in the pressure vessel and in the primary cooling system during assembly.

32515 Closure system for nuclear reactors with pressure vessel. Kube, L.J. (to General Atomic Co.). French Patent 2,281,633/A/. 7 Aug 1975. 9p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 9 Aug 1974, US.

The closure system described is for a gas cooled nuclear reactor with a pressure vessel fitted with an internal penetration to take a heat exchanger. This closure system includes a tube plate mounted crosswise to the penetration and aligned on its centre line for supplying a heat exchange fluid to the heat exchanger, a retaining ring demarcating an aperture smaller in diameter than that of the periphery of this plate and fitments for mounting the ring on the pressure vessel to maintain it in the penetration, aligned on its centre line so as to prevent the tube plate for moving into the pressure vessel. This closure system includes flow restrictors between the defect protection cylinder and the thermal sleeve.

32516 Evaporator. Bennett, R.R. (to Westinghouse Electric Corp.). French Patent 2,285,573/A/. 15 Sep 1975. 6p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 18 Sep. 1974, US.

The evaporator described uses a primary fluid to evaporate a secondary one. It includes a vertical shell, a tube plate located near the bottom end of this shell, a cluster formed by a given number of U tubes fitted to the tube plate and in which flows a primary heating fluid so as to form a hot and a cold branch. A sleeve encompasses the tube cluster so as to form an annular chamber between the sleeve and the shell. There is a flow distribution plate adjacent to, but clear of the tube plate, so as to form a return space communicating with the annular chamber. An extraction tube is connected to the shell for withdrawal of the secondary fluid. The distribution plate is fitted with an aperture that is central in relation to the hot branch of the tube cluster, this extraction tube extending through the space between the tube plate and the distribution plate. This tube plate has a section transversal to the aperture and provided with a number of apertures for withdrawing the secondary fluid from the area adjacent to the tube plate below the opening of the flow distribution plate. The extraction tube is generally T shaped and is composed of a rod and a transverse part, the orifices being located on this transverse part.

32517 Method to design shell-side pressure drop constrained tubular heat exchangers. Singh, K.P.; Holtz, M. (Joseph Oat Corp., Camden, NJ). *Am. Soc. Mech. Eng., [Pap.]*: No. 76-JPGC-NE-1, 1-8(1976).

In shell and tube heat exchangers, the triple segmental baffle arrangement has been infrequently used, even though the potential of this baffle system for high thermal effectiveness with low pressure drop is generally known. This neglect seems to stem from the lack of published design guidelines on the subject. Lately, however, with the rapid growth in the size of nuclear heat exchangers, the need to develop unconventional baffling pattern has become increasingly important. A method to utilize effectively the triple segmental concept to develop economical designs is presented herein. The solution technique given in this paper is based on a flow model named 'Piecewise Continuous Cosine Model.' The solution procedure easily lends itself to detailed analysis to determine safety against flow-induced vibrations. 20 refs.

32518 Stress relaxation of welds in nuclear construction. *Tech. Mod.;* **68**: No. 6, 57-59(Jun 1976). (In French).

Several types of equipments for solving problems of stress relaxation of welds are described: large furnaces for preheating during forming and assembling and for intermediate and final heat treatments; electric resistance heating equipment for local weld treatment; and furnaces provisionally built on the assembling premises for a single treatment operation.

32519 Titanium application in nuclear power plants using seawater as a coolant. Andrieux, B. *Tech. Mod.;* **68**: No. 7, 29-30(Jul 1976). (In French).

Sea-water tests of titanium tubes have been carried out by 'Electricite de France' in experimental facilities and in thermal power plant condensers. The utilization of these tubes involves important advantages particularly a good corrosion and erosion resistance, an improved heat exchange because of tube thickness, and an increase of water flow.

32520 Possibility of a heating surface reduction in steam generators by means of a gas mixture as coolant in the power plant. Tetelbaum, S.D.; Gribovskii, V.P.; Klok, A.M.; Potapov, V.F.; Slobodyanik, N.P. (Odesskij Politekhnicheskij Inst. (Ukrainian SSR)). *Arch. Energiewirtsch.;* **30**: No. 8, 692-696(Aug 1976). (In German).

1 fig.; 1 tab.; 10 refs. Translated from Russian: O vozmoznosti sokrascenija teploobmennoj poverchnosti parogeneratorov pri ispol'zovanii smesi gazov v kacestve teplonositelja AES, from Izvestija VUZov, Energetika (1976) v. 19(1) p. 66-70.

In the present work the possibilities of a reduction of the heating surface of the steam generator in the power plant by using a particularly effective coolant are investigated. The use of a mixture of He and 'heavy gases' in a certain ratio as coolant in the primary circuit of two-circuit reactors enables the heat transfer surfaces of the steam generator to be reduced by at least 30 to 35 % as compared to a power plant where pure gases are used as coolant.

32521 Method for analyzing low ion-contents in solutions and apparatus thereof. Dahl, G.L.; Lundqwist, N.R. (to Aktiebolaget Atomenergi). Swedish Patent 388,042/B/. 20 Sep 1976. 8p. (In Swedish).

A method for analyzing low ion-contents in solutions, in particules very low chlorine-ion contents in water of high purity e.g a condensate, characterized by pre-concentrating a sample of the solution through electro-dialysis by transforming the ion to be determined into an ion of another type or another elementary form, then dosing the thus-obtained concentrated solution through photometry.

32522 Calandria vessels for nuclear reactors. Hewins, J.A. (to UKAEA). Canadian Patent 997,873. 28 Sep 1976. 6p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

According to the invention a calandria vessel is incorporated in a calandria and neutron shield unit comprising an assembly of tanks for containing neutron shield material arranged to bound a sealed inner chamber for containing liquid moderator, and open end tubes which extend through the chamber and are sealed into aligned passages of opposed tanks.

32523 Nuclear reactor core stabilizing arrangement. Jabsen, F.S. (to Babcock and Wilcox Co.). US Patent 3,987,860. 26 Oct 1976. Filed date 19 Sep 1973. 6p.

A nuclear reactor core stabilizing arrangement is described wherein a plurality of actuators, disposed in a pattern laterally surrounding a group of elongated fuel assemblies, press against respective contiguous fuel assemblies on the periphery of the group to reduce the clearance between adjacent fuel assemblies thereby forming a more compacted, vibration resistant core structure. 7 claims, 4 drawing figures.

32524 Pipe restraints for nuclear power plants. Keever, R.E.; Broman, R.; Shevekov, S. (to Nuclear Services Corp.). US Patent 3,987,991. 26 Oct 1976. Filed date 18 Sep 1973. 4p.

A pipe restraint for nuclear power plants in which a support member is anchored on supporting surface is described. Formed in the support member is a semicylindrical wall. Seated on the semicylindrical wall is a ring-shaped pipe restrainer that has an inner cylindrical wall. The inner cylindrical wall of the pipe restrainer encircles the pressurized pipe. In a modification of the pipe restraint, an arched-shaped pipe restrainer is disposed to overlie a pressurized pipe. The ends of the arch-shaped pipe restrainer are fixed to support members, which are anchored in concrete or to a supporting surface. A strap depends from the arch-shaped pipe restrainer. The pressurized pipe is supported by the depending strap.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 32102, 32800, 32849

32525 (INIS-mf—3224, pp 115-117) **Development and validation of a finite element model for fuel behaviour in transients.** Banerjee, S.; Bridges, H.J.; Too, J.J.M. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment); Hsu, T.R. (Manitoba Univ., Winnipeg (Canada). Dept. of Mechanical Engineering). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 1 fig. and 8 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32526 (INIS-mf—3224, pp 54-55) **Status of zircaloy deformation and oxidation research at Oak Ridge National Laboratory.** Chapman, R.H.; Cathcart, J.V.; Hobson, D.O. (Oak Ridge National Lab., Tenn. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water eactor fuel elements under accident conditions.

32527 (INIS-mf—3224, pp 103) **In-pile measurements of fuel rod deformation prior to accident conditions.** Joon, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32528 (INIS-mf—3224, pp 104-105) **GAPCON 3: a computer code to analyse the path dependent thermal and mechanical performance of nuclear fuel rods.** Mohr, C.L.; Lanning, D.D.; Panisko, F.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32529 Method and device for the preparation of homogeneous portions of loose materials especially of fluid materials. Rachor, L.; Porth, H. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG)). German(FRG) Patent 2,333,094/A/. 9 Jan 1975. 7p. (In German).

1 fig.

For producing a very homogeneus mixture of fluid materials, e.g. nuclear fuel particles, the basic quantity is pre-mixed and divided by rotating portion dividers. The partial quantities are re-united and divided once again. The segregation of these second portions is prevented by collecting them in long, very narrow vessels and extracting them through bottom openings. The device is represented schematically. The method is described by the example of a mixture of $(U,Th)O_2$ particles and UO_2 particles, each coated by pyrolytic plastics and the particle diameters of which amount 650 μm and 400 μm.

32530 Improvements in or relating to nuclear reactor fuel element assemblies. Leaver, B.; Mercer, W. (to UKAEA). Australian Patent 466,313/B/. 8 Oct 1975. 13p.

Filed 6 Jul 1972, publ. 10 Jan 1974, priority UK 7 Jul 1971 (71/32005), copies available from the Commissioner of Patents, Canberra.

A description is given of a fuel element assembly of the kind including: 1) a plurality of elongate fuel pins supported in a bundle with their longitudinal axes parallel to the axis of a spacer grid; 2) the spacer grid comprising intersecting strip members which extend in at least two directions between parallel rows of the fuel pins in the fuel element assembly; 3) at least one of the strip members comprising a pair of closely spaced parallel strip elements spaced in a direction perpendicular to the axis of the spacer grid, the pair of strip elements extending between one row of the fuel pins and the next, the intersecting strip members defining a plurality of cells each penetrated by a fuel pin, and the fuel pins being laterally located in the fuel element assembly by contact with the walls of the cells.

32531 Improvements in or relating to fuel assembly for a nuclear reactor. Ferrari, H.M.; Miller, D.L.; Tong, L.S. (to Westinghouse Electric Corp.). Australian Patent 469,610/B/. 3 Feb 1976. 15p.

Filed 14 Aug 1973, publ. 20 Feb 1975, priority USA 26 Sep 1972 (292379), copies available from the Commissioner of Patents, Canberra.

A fuel assembly is described for a nuclear reactor comprising: 1) an array of fuel rods mounted between a base and an upper support member, 2) at least one support grid comprising multiple straps interwoven with each other to form therebetween openings for receiving the fuel rods for laterally supporting and holding the fuel rods in spaced relationship with each other, 3) rigid means formed integral with the straps and projecting from two adjacent straps into each opening to contact the respective fuel rod therein, 4) and resilient means formed integral with the straps and projecting from the other two adjacent straps into each opening to force the

fuel rod into firm engagement with the rigid means, the straps having cut-out areas at their leading edges in line, with respect to the direction of flow of coolant through the assembly, with the rigid and resilient means so as to maintain uniformity of coolant flow speed through the grid.

32532 Nuclear reactor spacer device. Carlson, R.C.; King, L.L.; Sofer, G.A. (to Exxon Nuclear Co.). Canadian Patent 994,015. 27 Jul 1976. 19p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

The spacer device described comprises a peripheral support band having substantially open-webbed corner members and improved scooped side members, intersecting support strips connected to the peripheral support band, and spring assemblies held in the desired positions by the support strips.

32533 Detection of fuel pin leakage. Worlton, D.C.; Robinson, D.L. (to Exxon Nuclear Co.). Canadian Patent 994,014. 27 Jul 1976. 9p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

It has been found that fuel pin leakage can be rapidly determined without removing the fuel pin from the reactor core by measuring the vibrational characteristics of a flexible means located in a specially constructed upper end cap assembly.

32534 Coolant mixing vanes. Pugh, R.A.; Sofer, G.A.; Leach, C.E. (to Exxon Nuclear Co., Inc.). Canadian Patent 994,928. 10 Aug 1976. 12p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

A fuel assembly is described with coolant deflecting vanes which effect a vortex shaped coolant flow pattern. When assembled into a core, said fuel assemblies provide improved heat transfer and lower temperature gradients between all regions of the reactor core.

32535 Oxyde mixture fuel containing uranium and plutonium dioxides and process to obtain this oxyde mixture. Hannerz, K. (to ASEA-ATOM AB). Swedish Patent 387,188/B/. 30 Aug 1976. 6p. (In Swedish).

An oxide-mixture fuel containing uranium and plutonium dioxides having the slage of spherical, or nearly spherical, oxide-mixture particles with a diameter within the range of from 0.2 to 2 mn charactarized in that each oxide-mixture particles is provided with an outer layer comprising mainly UO2, the thickness of which is at least 0.05; whereas the inner portion of the oxide-mixture particles comprises mainly PUO 2.

32536 Nuclear-reactor fuel-assembly with readily separated constituent parts. van Santen, T. (to ASEA-ATOM AB). Swedish Patent 387,766/B/. 13 Sep 1976. 4p. (In Swedish).

The invention relates to a fuel assembly with readily separated constituent parts. Such an assembly comprises fuel rods provided with upper and lower terminal plugs, a lower plate and an upper plate forming a grid, some of the upper terminal plugs having a compression spring wound therearound while other plugs comprise and extension situated above the upper plate and adapted to receive a nut, the movements of rotation of said nuts being restricted by at least one depending nut-protrusion, the end-surface of which is under the upper edge of a grid said of the upper plate. Such an arrangement permits to redice the spacing between the upper and lower plates wherever a downwarly-directed is exerted on the upper plate, so as to suppress the locking of the nut..

32537 Pressurized fuel elements for nuclear reactors. Wehrli, H.A. III; DeMario, E.E.; Hovanec, T.R. (to Westinghouse Electric Corp.). Canadian Patent 998,189. 5 Oct 1976. 12p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

An internally pressurized hermetically clad fuel element for a nuclear reactor having a sealed collapsible capsule within the fuel element plenum is described. The capsule is controllably collapsed with increases in plenum pressure to maintain the pressure substantially constant throughout its operating life.

32538 Nuclear reactor fuel rod thermal simulator. Hill, E.F. (to Varian Associates). US Patent 3,988,565. 26 Oct 1976. Filed date 14 Nov 1974. 8p.

The tubular stainless steel structure of a nuclear reactor fuel rod thermal simulator is heated to nuclear fuel rod operating temperatures by means of a gaseous glow discharge established within the tubular structure. In a preferred embodiment a length of the simulated fuel rod is internally clad with tungsten, or Mo or alloys thereof, hermetically sealed at both ends and filled with a glow discharge sustaining gas such as hydrogen or helium. A center electrode structure, as of tungsten, or Mo or alloys, is centrally disposed within the gas filled tubular envelope. Power is applied between the center electrode and the outer tubular envelope for initiating and sustaining the glow discharge for heating the outer tubular envelope to nuclear fuel rod simulating temperature. 14 claims, 6 drawing figures.

32539 Nuclear fuel element. Penrose, R.T.; Thompson, J.R. (to General Electric Co.). US Patent 3,988,075. 26 Oct 1976. Filed date 2 Mar 1973. 8p.

A method of protecting the cladding of a nuclear fuel element from internal attack and a nuclear fuel element for use in the core of a nuclear reactor are disclosed. The nuclear fuel element has disposed therein an additive of a barium-containing material and the barium-containing material collects reactive gases through chemical reaction or adsorption at temperatures ranging from room temperature up to fuel element plenum temperatures. The additive is located in the plenum of the fuel element and preferably in the form of particles in a hollow container having a multiplicity of gas permeable openings in one portion of the container with the openings being of a size smaller than the size of the particles. The openings permit gases and liquids entering the plenum to contact the particles. The additive is comprised of elemental barium or a barium alloy containing one or more metals in addition to barium such as aluminum, zirconium, nickel, titanium and combinations thereof. 6 claims, 3 drawing figures.

32540 Getter for nuclear fuel elements. Ross, W.T.; Williamson, H.E. (to General Electric Co.). US Patent 3,993,453. 23 Nov 1976. Filed date 13 Jun 1975. 8p.

A nuclear fuel element for use in the core of a nuclear reactor is disclosed and has disposed therein an improved getter capable of gettering reactive gases including a source of hydrogen. The getter comprises a composite with a substrate having thereon a coating capable of gettering reactive gases. The substrate has a greater coefficient of thermal expansion than does the coating, and over a period of time at reactor operating temperatures any protective film on the coating is fractured at various places and fresh portions of the coating are exposed to getter reactive gases. With further passage of time at reactor operating temperatures a fracture of the protective film on the coating will grow into a crack in the coating exposing further portions of the coating capable of gettering reactive gases. 13 claims, 5 drawing figures.

CONTROL SYSTEMS

32541 (CEA-CONF—3498) Instrumentation for nuclear reactor control. Plaige, Y. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). 10 Mar 1976. 19p. (In French). (CONF-760386—2). NTIS (US Sales Only).

From Meeting on nuclear power plant control; Saclay, France (8 Mar 1976).

This lecture is concerned with engineers and technicians not specialized in nuclear reactor control. The different methods of measurement used are briefly reviewed: current or pulse measurement, and Campbell system; the electronic networks are described and a part is devoted to the cables connecting detectors and electronic assemblies.

32542 (ERGPRO-nn—1) Reliability and fault tree applications at the NRTS. Vesely, W.E. (Energoprojekt, Prague (Czechoslovakia)). 1976. 24p. (In Czech). NTIS (US Sales Only).

Translated from IEEE Transactions on Nuclear Sciences (1971) v. 18(1) p. 472-480. Available from Nuclear Information Centre, Praha-Zbraslav, Czechoslovakia.

The significance is discussed of the fault tree analysis in obtaining information on safety and reliability of nuclear reactor protection and control systems. The principle of the method is described and the basic characteristics of the method are defined. Computer programmes PREP and KITT written in FORTRAN IV for the IBM 360/75 computer are described. The programmes are used to obtain the characteristics of the individual components, of the critical paths, etc. for the fault tree solution. Examples are given of the use of the fault tree analysis in solving specific systems.

32543 (PNC-J—261-75-01) Study of rare earth elements as material for control rods. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Mar 1975. 77p. (In Japanese). TIC.

405 refs.

The properties of rare earth elements as the material for control rods were studied. The rare earth elements, especially europium oxide, has the nuclear property corresponding to boron carbide, and its neutron absorption process does not emit alpha particles. The elements produced as a result of neutron capture also have large capture cross sections. The paper presents a survey report on the properties and nuclear properties of rare earth elements, and comparison with other materials. Preliminary experiment was performed to make the pellets of europium oxide, and is described in the paper. Because of large density, the crystal form to be made was monoclinic system. Europium hydroxide was decomposed at 1000°C and 10^{-5} torr. The obtained powder was dipped into benzene, and

dryed in the air at 450°C. This powder was pressed and sintered in the air for one hour at 1500°C. The density of the obtained pellets was 97.0% of the theoretical density. The cross section of europium for fast neutron absorption is not yet accurately obtained, and is in the range between 4.65 and 8.5 barn for $^{151}Eu(n,\gamma)$ reaction. Since chain absorption reaction is caused in Eu, the overall capability of neutron absorption is not much changed by the loss of original material due to absorption. The pellets of europium oxide may be handled in air, but must be kept in dry atmosphere. The reactions of europium oxide with various metals were also investigated. The characteristic behavior in case of irradiation depends on the amount of silicon contained, and it was very good if the amount was less than 0.03%.

32544 (RD/B/N—3479) **Review of control rod calibration methods for irradiated AGRs.** Telford, A.R.R. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Oct 1975. 23p.p. NTIS (US Sales Only).

Methods of calibrating control rods with particular reference to irradiated CAGR are surveyed. Some systematic spatial effects are found and an estimate of their magnitude made. It is concluded that control rod oscillation provides a promising method of calibrating rods at power which is as yet untried on CAGR. Also the rod drop using inverse kinetics provides a rod calibration but spatial effects may be large and these would be difficult to correct theoretically. The pulsed neutron technique provides a calibration route with small errors due to spatial effects provided a suitable K-tube can be developed. The xenon transient method is shown to have spatial effects which have not needed consideration in earlier reactors but which in CAGR would need very careful evaluation.

32545 **Regulating assembly for nuclear reactors.** Budnikov, V.A.; Evseev, V.I.; Samoilov, O.B.; Sukharev, J.P. French Patent 2,285,683/A/. 23 Sep 1974. 9p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The nuclear reactor regulating assembly described comprises components containing a neutron absorbing substance and a chamber communicating with them for collecting the gas discharged when this substance is absorbing the neutrons. Its salient feature is that the components containing the absorbing substance are placed according to a circumference and the gas collecting chamber is located within this circumference. This assembly is mainly intended for fast neutron reactors.

32546 **Nuclear reactor control method for maintaining an appreciably constant axial distribution of power with load variations.** Morita, T. (to Westinghouse Electric Corp.). French Patent 2,283,515/A/. 28 Aug 1975. 34p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 29 Aug 1974, US.

A nuclear reactor control method is described in which the power variations of the reactor are controlled partly by varying the concentration of the neutron absorbing element and partly by varying the positions of the control rods, in order to maintain the axial distribution of power appreciably symmetrical during the normal operation of the reactor. The control points are located in the upper and lower halves of the core. The controls are operated to maintain the output power difference between the upper and lower halves of the core, based on the total output power (axial deviation) significantly equal to a predetermined optimum figure during the entire running of the reactor, including when there are power variations. The optimum value is obtained by determining the axial deviation at full power with the xenon in balance and all the control rods withdrawn from the fuel area of the core. This optimum value is recalculated after a period appreciably equal to that of a month's operation at full power. This method applies in particular to PWR type reactors.

32547 **Liquid metal control system for a nuclear reactor.** Platatsis, Eh.Ya.; Tomsons, Eh.Ya.; Gavars, V.V. *At. Energ. (USSR);* **39**: No. 5, 358(Nov 1975). (In Russian).

Deposited article; for English translation see the journal Sov. J. At. Energy.

32548 **Nuclear-reactor adjusting device comprising a screw provided with rollers at the extremity thereof.** Berglund, A.; Suvanto, A. (to ASEA-ATOM AB). Swedish Patent 386,530/B/. 9 Aug 1976. 10p. (In Swedish).

This adjusting device for nuclear reactors where in the control-rod is inseted into the core from the bottom, is of the type described in Swedish Patent A 314, 749. The upper end of the control-rod driving screw is mounted in a hollow piston by means of several rod-shafts each of which is fixed by one end to the extremity of the screw, extends substantically in the axial direction and is situated, for the greater portion thereof, outside said screw extremity, each of said rod-shafts being provided at the other end thereof, with a roller co-axially mounted with respect to the corresponding rod-shaft, said roller being addapted to roll along the inner periphery of the hollow piston and, in addition, to slide along a major portion of the length of piston on the cylindrical inner surface of the latter.

32549 **Nuclear-reactor adjusting device comprising a piston mounted on guide-rollers.** Berglund, Aa.; Suvanto, A. (to ASEA-ATOM AB). Swedish Patent 386,531/B/. 9 Aug 1976. 10p. (In Swedish).

Description is given of an adjusting device for reactors comprising a control-rod inserted from the bottom into the nuclear-reactor core. A tubular guide-member surrounds the control-rod driving screw, and the hollow piston of the hydraulic drive system sealinglyinserted in a opening of a portion of said guide-member, the lightness being obtained by means of a labyrinth-seal in the form of a plurality of annular grooves made en a cylindrical surface of said opening, whereas a friction less connection beween said cylindrical surface and the hollows piston surrounded by the latter, is provided by a plurality of quide-rollers mounted on horizontal shafts, each of said rollers being inserted in a pocket made in said wall-portion and turned towards said hollow piston.

32550 **Bottom actuated reactor control system.** Bevilacqua, F.; Dietrich, J.R.; Flinn, W.S.; Groves, M.D.; West, J.A. (to Combustion Engineering). Canadian Patent 998,477. 12 Oct 1976. 22p.

Available from Supply and Services Canada, Publishing Center, Ottawa.

The control system described consists of a comparatively large number of low worth absorber elements associated with individual hydraulic actuator assemblies. Advantages claimed are reduced axial distortions, reduced sealing requirements and a clean reactor head, prevention of control rod blow-out, and a simplified power scram mode of operation.

32551 **Control assembly of a nuclear reactor.** Kuzavkov, N.G.; Pakhomov, V.V.; Prin, I.I.; Shabalin, A.S. US Patent 3,988,203. 26 Oct 1976. Priority date 14 May 1973, Union of Soviet Socialist Republics (USSR). 6p.

The control assembly of a nuclear reactor according to the invention comprises a sleeve stationarily mounted in the fuel core of the reactor and accommodating a casing movable therein. The casing accommodates two superposed concentric sections formed by fuel and absorbing elements, respectively. Approximately at the boundary between the sections, the casing is provided with openings adapted to remove a part of a cooling medium flowing around said sections and into a space formed between the casing and sleeve. In order to control the flow rate of this part of the cooling medium, depending on the position of the casing relative to the fuel core of the reactor, a throttle means disposed in the zone of the section formed by the absorbing elements is provided. 2 claims, 3 drawing figures.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 33117

SITING

32552 (BNL—50561) **Issues in clustered nuclear siting: a comparison of a hypothetical nuclear energy center in New Jersey with dispersed nuclear siting.** Meier, P.M.; Morell, D. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1976. Contract EY-76-C-02-0016. 418p. Dep. NTIS $11.00.

The report is an analysis of a hypothetical nuclear energy center (NEC) conducted in support of the recently completed study by the Nuclear Regulatory Commission, mandated by the Congress in the Energy Reorganization Act of 1974. The intent of the analysis of the hypothetical, or "surrogate", site was to inject a local and regional perspective into the assessment of technical, environmental, institutional, and socioeconomic issues which could be adequately addressed only by reference to a specific site. The hypothetical NEC site in Ocean County, New Jersey, was chosen to illustrate the problems and impacts of potential energy centers in coastal and near-coastal sites in relatively close proximity to large metropolitan areas. Earlier studies of hypothetical energy centers on the Mississippi River at River Bend, La., and on the Columbia River near Hanford, Washington, were also re-examined for their relevance to this new study effort. Neither Ocean County, nor any of the other surrogate sites, have been considered for actual construction of an NEC, nor does their selection for study purposes imply any judgement of desirability. Indeed, the major finding of the report presented is that Ocean County is a relatively poor location for an energy center, and this may well be true of many coastal locations similar to the Jersey shore. The objective in selecting surrogate sites, then, was not to find the best locations, but to select sites that would illustrate the broadest range of potential public policy and siting issues.

32553 (INIS-mf—3254) **Rock siting of nuclear power plants from a reactor safety standpoint.** (Centrala Driftledningen, Vaellingby (Sweden)). Nov 1975. 37p. NTIS (US Sales Only).

The study has aimed at surveying the advantages and disadvantages of a rock sited nuclear power plant from a reactor safety standpoint. The studies performed are almost entirely concentrated on the BWR alternative. The design of a nuclear power plant in rock judged most appropriate has been studied in greater detail, and a relatively extensive safety analysis has been made. It is found that the presented technical design of the rock sited alternative is sufficiently advanced to form a basis for further projecting treatment. The chosen technical design of the reactor plant demands a cavern with a 45-50 metre span. Studies of the stability of such caverns show that a safety level is attainable corresponding to the safety required for the other parts of the nuclear power plant. The conditions are that the rock is of high quality, that necessary strengthening measures are taken and that careful studies of the rock are made before and during the blasting, and also during operation of the plant. When locating a rock sited nuclear power plant, the same criteria must be considered as for an above ground plant, with additional stronger demands for rock quality. The presented rock sited nuclear power plant has been assessed to cost 20 % more in total constructioncosts than a corresponding above ground plant.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 33251, 33253

32554 Radioactive effluents from German nuclear power stations and nuclear research centers in 1974. *Atomwirtsch., Atomtech.;* **21**: No. 12, 593-595(Dec 1976). (In German).

5 tabs. Short communication only.

32555 Radioactive effluents from nuclear power stations in the European Community in 1970-1974. *Atomwirtsch., Atomtech.;* **21**: No. 12, 590-593(Dec 1976). (In German).

7 tabs. Short communication only.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 32429, 32588, 32595, 32639, 32640, 32641, 32642, 32643, 32649, 32651, 33093

32556 (AECL—5310, pp 29-33) **Fault tree analysis of WR-1.** Coady, J.R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment); Turner, D.G. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). Feb 1976.

In AECL research and development in engineering, winter 1975.

To increase confidence in the fault tree technique the authors analyzed the protective system of WR-1 research reactor at Pinawa, Manitoba. Results of the analysis agreed well with the experience of ten years of operation.

32557 (ANL/RAS—76-34, pp 27p., Paper 6) **Performance review: neutron hodoscope at TREAT.** Stanford, G.S.; DeVolpi, A.; Fink, C.L.; Regis, J.P.; Rhodes, E.A.; Stewart, R.R. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The current fuel-motion-detection capabilities of the neutron hodoscopes at TREAT are outlined and discussed, including such topics as spatial and fuel-density resolution, dynamic range, and corrections for detector dead time and supralinearity. Capabilities and analytical techniques are illustrated with examples from several of the power-transient experiments that have been run in the TREAT reactor.

32558 (ANL/RAS—76-34, pp 8p., Paper 7) **Improvements in the TREAT hodoscope system.** Fink, C.L.; DeVolpi, A.; Stewart, R. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

Recent modifications and tests performed on the hodoscope system at TREAT are reviewed. The major effort has been spent in correcting minor deficiencies and in improving and upgrading the performance and reliability of a successful time-resolved fuel detection system.

32559 (ANL/RAS—76-34, pp 8p., Paper 8) **CABRI hodoscope.** Bluhm, H. (GfK Karlsruhe, Ger.); Boehnel, K.; Kuechle, M.; Agaisse, R.; Aujollet, J.M.; Dadillon, J. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

Design features and capabilities of the CABRI hodoscope are briefly reviewed. (DG)

32560 (ANL/RAS—76-34, pp 35p., Paper 9) **Material motion capabilities for SAREF.** DeVolpi, A. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The SAREF program requires a panoply of diagnostic techniques in order to obtain needed experimental information. After surveying various fuel motion monitoring techniques, the hodoscope has been chosen as the reference device because of its proven record and because data extrapolations and calculations indicate adequate response for small and large test sections. A hodoscope system for STF would be designed to perform both fuel and clad monitoring during transients. It would also provide distinctive fuel and clad radiographic information before and after transients. Large-test resolution of less than 100 gm and time resolution down to 0.1 msec are projected. Two orthogonal collimators for three-dimensional viewing would each cover 180 x 31 cm viewing area with a combined total of 6000 detectors.

32561 (ANL/RAS—76-34, pp 10p., Paper 10) **ACPR upgrade fuel motion detection system.** Kelly, J.G.; Stalker, K.T. (Sandia Labs., Albuquerque, NM). 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

Coded aperture imaging techniques are being applied to the problem of fuel motion detection in core disruptive safety experiments in the LMFBR. The upgraded Sandia Annular Core Pulse Reactor will be used for fuel motion studies, and a system is now being developed to image fuel motion through a slot in the core in 1- and 7-pin experiments. The γ-rays emitted by the fuel will be modulated by a coded aperture and will form a pseudohologram on a scintillator. This shadowgram will be lens coupled first to an optical image intensifier, and then to a rotating prism framing camera. The goal is to obtain quality images of fuel with approximately 1 mm spatial resolution at about 10^4 frames/sec. Some of the feasibility milestones which have been reached thus far are the following: (1) A fuel pin shaped ^{252}Cf fission gamma ray source has been imaged through 1.27 cm of steel (simulating reactor containment). (2) A ^{252}Cf source has been imaged through 1.27 cm of steel with x-ray image intensifier amplification. (3) Collimation and shielding tests indicate that at ACPR it should be possible to obtain adequate signal to noise at the detector when the fuel is observed through a slot in the core.

32562 (ANL/RAS—76-34, pp 9p., Paper 11) **Preliminary report on the Pinex at TREAT.** Berzins, G.J.; Han, K.S.; Roach, W.H. (Los Alamos Scientific Lab., NM). 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The neutron image of a GETR fuel pin was observed in a pinhole experiment (Pinex) performed at TREAT. The signal amplitude, recorded with intensified television cameras, compared well with expectations. The results carry favorable implications for continued development of nonredundant pinhole array techniques, as well as for refinement of single pinhole experiments, as diagnostic tools for the LMFBR safety program.

32563 (ANL/RAS—76-34, pp 33p., Paper 12) **Evaluation of ex-core imaging appertures for STF.** Rhodes, E.A. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The relative merits of some candidate apertures for use in monitoring material motion in reactor transient tests to be conducted at the proposed Safety Test Facility are investigated. It is found that a hodoscope has the greatest probability of success in meeting established requirements, but that a pinhole or pinhole-hodoscope could be advantageous under certain circumstances. A Fresnel zone plate-hodoscope is found to be less suitable, and the two-dimensional nonredundant pinhole arrays and Fresnel zone plates studied are found to be unsuitable. Although based in part on numerical calcula-

tions for fuel motion detection by neutron emission only, these conclusions are thought to be valid for material motion detection by γ-ray emission and flash x-radiography as well.

32564 (CEA-N—1886) **Measurement of the gamma field around Silene reactor.** Spurny, F.; Medioni, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Jul 1976. 26p. (In French). NTIS (US Sales Only).

A method for measuring the gamma component in the mixed field emitted by the Silene facility in Valduc is investigated. Various thermoluminescent phosphors (natural LiF, ^{7}LiF, SO_4Ca, Al_2O_3) in containers of different sizes and types are used. The detectors results are corrected for their neutron sensitivity by using coefficients which were determined in previous studies. Alumina is shown to be the most suitable detector for this problem because of the dose ranges to be measured and its low sensitivity to neutrons. A series of measurements carried out at many points in the irradiation hall shows a good homogeneity in the gamma distribution. Results are given for different distances from the source and for a 10^{17} fissions power of the reactor.

32565 (GKSS—76/E/35) **Research and test reactors.** Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Zentralabteilung Forschungsreaktoren). 1976. 28p. (In German). U PC A03/MF A01.

From Technical seminar no. 5 1975/76; Hanau, Germany, F.R. (27 Apr 1976).

15 figs.

It is a report on the fuel cycle of research and test reactors. The construction and running of the reactor are described, and the influence of geometry on the reactor design is shown in particular. Demands for security are made and the present utilisation of research and test reactors is described. An attmpt has been made to give information on the future outlook of research and test reactors.

32566 (HEDL-SA—806FP) **Single carrier method for the emission spectrometric analysis of uranium—plutonium oxides.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(45-1)-2170. 5p. (CONF-761135—2). Dep. NTIS $3.50.

From American Chemical Society Pacific conference; Phoenix, Arizona, United States of America (USA) (7 Nov 1976).

The paper describes a single carrier emission spectrometric method developed for the impurities analysis of mixed oxide fuels scheduled to be loaded into FFTF. The mixed oxide fuels analysis is made on a Baird direct reading emission spectrometer using the carrier distillation technique.

32567 (HEDL-TC—25, pp III.1-III.77) **Atomics International sodium and sodium oxide deposits in the FTR head shielding.** Shimazaki, T.S. Jul 1974.

In Sodium frost technology.

The report represents the culmination of the AI effort to predict the performance of the FFTF reactor vessel head thermal baffles. The report is a mathematical analysis to predict frost accumulation in the thermal baffles of the FTR head shielding. The data concludes that frost will not bridge the thermal reflector shields. The recommended experimental work was canceled due to the absence of justification for funding with available resources.

32568 (HEDL-TI—76032) **FFTF operations procedures preparation guide. Revision 2.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Dec 1976. Contract EY-76-C-14-2170. 65p. Dep. NTIS $4.50.

The Guide is intended to provide guidelines for the initial preparation of FFTF Operating Procedures. The Procedures Preparation Guide was developed from the plan presented and approved in the FFTF Reactor Plant Procedures Plan, PC-1, Revision 3.

32569 (INDC(CCP)—66/U, pp 21) **Creation of a standard source (field) of neutrons in the MR reactor of the I.V. Kurchatov Institute of Atomic Energy (IEA).** Vasil'ev, R.D.; Galiev, N.B.; Yaryna, V.P. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Fiziko-Tekhnicheskikh i Radiotekhnicheskikh Izmerenij, Moscow (USSR)); Babulevich, P.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Kononovich, A.A.; Mitel'man, M.G.; Rozenblyum, N.D.; Shipovskikh, Yu.M. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Istochnikov Toka, Moscow (USSR)); Inikhov, A.I.; Petrov, V.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Soyuznyj Nauchno-Issledovatel'skij Inst. Priborostroeniya). Feb 1976.

Translated from Russian. Published in summary form only.

In Nuclear physics research in the USSR. Collected abstracts. Issue 20.

32570 (INIS-mf—3351) **Aqueous homogeneous suspension reactor project. Report on the 1st quarter 1976.** (Keuring van Elektrotechnische Materialen N.V., Arnhem (Netherlands). Reactor Development Group). 1976. 18p. U PC A02/MF A01.

List of reports.

During the 1st quarter of 1976, reactor operation has been restarted. Difficulties during reactor operation such as release of radiolytic gas, loss of fuel, blocking of sampling bypass, leakages from N_2 supply system, are reported. Instrumental performance, maintenance and repair actions undertaken are mentioned, as are the safety of KSTR operation and radiological safety.

32571 (RD/B/N—3556) **MASTER: a program for the reactor physics counting laboratory's PDP8-E data acquisition system for controlling up to four sample changers simultaneously.** Cahill, J.D.; Kitching, S.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Dec 1975. 16p.p. NTIS (US Sales Only).

The reactor physics counting laboratory has a PDP-E computer system for data acquisition and control of automatic sample changers fitted to gamma ray detectors. The structure and working method are described, of a program for a PDP 8-E system which will acquire data, perform data reduction, and control up to four sample changers simultaneously. The use of this program has led to greater flexibility in the planning of reactor experiments and has been found to be operationally simpler than individual programs for each counting system.

32572 (RD/B/R—3750) **Analysis of HITREX-1 using the reactor physics methods of the Dragon Project/KFA and the CEGB(BNL) - a joint evaluation.** Hansen, U.; Neef, H.J.; Waterson, R.H. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1976. 82p.p. U PC A05/MF A01.

An analysis of the HITREX 1 reactor experiment has been jointly performed by the DRAGON project/KFA and the CEGB, Berkeley, applying methods and codes currently in use within these organisations. The different methods are described and the results of the analyses are compared with each other and with experiment. Although in general the various methods give comparable results, there are two areas of significant discrepancy. First, the thermalisation data in the DRAGON codes is shown to be inadequate, so that the Pu/U fission ratio is over-estimated by some 3%, and secondly, there are differences of about 2 or 3% in the ^{238}U absorption rates. From existing analyses, it is not possible to conclude which method gives the best overall representation of the resonance events. Concerning thermal reaction rate distribution, it is concluded that for an accuracy of about +- 1% it is necessary to perform a reactor spectrum calculation in many groups before condensation. The 32-group WIMS model achieves this, but the XSDRN/CITATION 10-group model does not. The DRAGON/KFA power reactor method predicts reaction rates in the core to within a few per cent. All methods grossly under-estimate the gradient of fast neutron flux at the core/reflector interface.

32573 (SAND—76-0653) **Annular core pulse reactor upgrade quarterly report, July—September 1976.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract EY-76-C-04-0789;NRC-PRJ-A1032. 58p. Dep. NTIS $4.50.

The object of the ACPR Upgrade is to arrive at a reactor modification which will provide an increased pulsed neutron fluence in the irradiation cavity without an increased degradation of the pulse duration. The upgraded reactor will also have an increased steady-state neutron flux. The approach to the upgrade modification involves a two-region core concept. The inner region, surrounding the irradiation cavity, consists of a high-heat-capacity fuel which will sustain a large fission energy deposition. The outer region consists of a uranium-zirconium hydride fuel similar to the present ACPR fuel. This reactor modification will make use of the majority of the existing reactor structure and can be accomplished in a relatively short time. Progress is summarized in the following task areas: safety, compliance, and documentation; core nuclear design; console development; mechanical design; fuel element design; UO_2-BeO fuel development; secondary fuel material studies; and driver core fuel element. (DG)

32574 (SAND—76-5547, pp 103-122) **Design characteristics of the CABRI-neutron hodoscope.** Bluhm, H. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Bohnel, K.; Kuchle, M.; Werle, H.; Agaisse, R.; Aujollet, J.M.; Dadillon, J. Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A hodoscope is described which will be installed at the CABRI transient overpower test facility which consists of a thermal swimming pool type driver reactor and a sodium test loop. The driver core contains fuel rods of UO_2 enriched to about 6% and can establish preburst power levels corresponding to about 450 W/cm in the test pin for a period of up to 30 minutes. Ramp rates of 10 to 100 $/sec leading to pulse widths at half maximum of between 5 and 200 msec are obtained by rapid depressurization of ^{3}He tubes located inside the core. The reactor will become critical in the second half of

1976 and a test programme of about five years duration has been planned. One principal goal of the CABRI-TOP experimental programme will be to provide experimental data to check and validate theoretical models to be incorporated in whole-core accident analysis code systems. Since only single-pin experiments have been projected, the tasks of the CABRI hodoscope have been restricted mainly to the determination of vertical fuel density changes because these are most important for negative reactivity feedbacks.

32575 (SAND—76-5547, pp 123-130) **Hodoscope collimator for 122-cm viewing height at TREAT.** De Volpi, A.; English, J.J.; Garrison, L.E.; Jamrog, A.R.; Kann, W.J.; Kush, R.W.; Pearson, C.V.; Pecina, R.J.; Rardin, D.C.; Travis, D.J. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

The fast neutron hodoscope at TREAT contains major subsystems for collimation, detection, pulse processing, data storage, and support facilities. The collimator was designed to measure fuel motion in experiments containing typically 34-cm EBR-II fuel pins. Transient tests with active fuel length of 91 cm are beginning to be performed. A new collimator system has been designed, fabricated, and partially installed at TREAT to satisfy requirements for extended fuel surveillance.

32576 (SAND—76-5547, pp 131-144) **Dielectric Track Detector fuel motion monitor system.** Dolce, S.R. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

The fuel motion monitor system described is one of the systems being developed for use in the upgraded Sandia ACPR. Like the hodoscope, this system will image fast neutrons from the test fuel element—but there the similarity to the hodoscope ends, because this system will use Dielectric Track Detectors (DTD's) for both neutron detection and recording. Kimfoil is a commercial polycarbonate film that is used as a capacitor dielectric. It is just one example of a Dielectric Track Detector. When a DTD is struck by an energetic and heavy ion, the ion produces damage along its path. If the dielectric is then etched, the damaged track enlarges to form a crater. These craters are then easily visible with an optical microscope. These dielectrics have several properties that make them ideal for use in a reactor environment. First of all, they are completely insensitive to any of the background radiations to which they can be exposed in that environment.

32577 (SAND—76-5547, pp 241-256) **Coded aperture material motion detection system for the ACPR.** McArthur, D.A.; Kelly, J.G. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Single LMFBR fuel pins are being irradiated in Sandia's Annular Core Pulsed Reactor (ACPR). In these experiments single fuel pins have been driven well into the melt and vaporization regions in transients with pulse widths of about 5 ms. The ACPR is being upgraded so that it can be used to irradiate bundles of seven LMFBR fuel pins. The coded aperture material motion detection system described is being developed for this upgraded ACPR, and has for its design goals 1 mm transverse resolution (i.e., in the axial and radial directions), depth resolution of a few cm, and time resolution of 0.1 ms. The target date for development of this system is fall 1977. The paper briefly reviews the properties of coded aperture imaging, describes one possible system for the ACPR upgrade, discusses experiments which have been performed to investigate the feasibility of such a system, and describes briefly the further work required to develop such a system. The type of coded aperture to be used has not yet been fixed, but a one-dimensional section of a Fresnel zone plate appears at this time to have significant advantages.

32578 (TUBIK—51) **Theoretical model to describe the dynamic behaviour of a ZrH-moderated pulse reactor.** Zayyeni, S.A. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik; Technische Univ. Berlin (Germany, F.R.). Fachbereich Verfahrenstechnik). 1976. 141p. (In German). U PC A02/MF A01.

43 figs.; 4 tabs.; 127 refs.

A theoretical model was devised to describe the dynamic behaviour of a ZrH-moderated pulse reactor by determining the distribution in space and time of the most important physical parameters like performance, temperature, heat flux, void fraction etc. using numerical solutions of the basic equations (kinetics equations, heat conduction and energy equations) and empirical correlations for heat transfer. The model provides for two-phase flow of the coolant and is hence capable of accounting for flow patterns resp. heat transfer region in the coolant channel by determining the onset of boiling resp. boiling-crisis. Thus, if relevant, burnout is detected. This renders possible the determining of the condition, under which pulse operation may damage the core. Geometrically the model is based on individual cells of the core, which consist of a fuel element and the surrounding coolant channel.

32579 **Maximizing the use of research reactors in training power reactor operating staff with special reference to US experience.** Cox, J.A. (Oak Ridge National Lab., Tenn. (USA)). *At. Energy Rev.;* **14**: No. 2, 387-406(1976).

Research reactors have been used in training nuclear power plant personnel for many years. Using the experience in the United States of America a programme is proposed that will maximize the training conducted at a research reactor and lessen the time that the staff must spend training elsewhere. The programme is adaptable to future training of replacement staff and for staff retraining.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 32156, 32527, 32542, 32724, 32725, 32726, 32729

32580 (AECL—5310, pp 8-10) **Heat transfer in the post-dryout regime.** Groeneveld, D.C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Feb 1976.

In AECL research and development in engineering, winter 1975.

Post-dryout heat transfer from fuel elements is important in the safety analysis of water-cooled nuclear reactors. Limited availability of relevant data has resulted in much uncertainty in the prediction of post-dryout fuel surface temperatures. Recent studies have permitted the development of a better prediction technique based on non-equilibrium effects.

32581 (AED-Conf—75-769-062) **Nuclear Emergency Assistance Team, a mobile intervention facility for nuclear accidents.** Koelzer, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1975. 24p. (CONF-7509129—140). NTIS (US Sales Only).

From Meeting on nuclear power plant project planning and implementation; Karlsruhe, German, Federal Republic of (F.R. Germany) (17 Sep 1975).

15 figs.

A nuclear emergency assistance team consisting of a vehicle pool and a stock of technical equipment was set up for operation in case of major reactor accidents. The equipment is kept in 6 containers which can be shipped on trucks, by rail or by helicopter or plane. Technical equipment and tasks of each container are briefly explained. Special transport vehicles for remote handling of contaminated material are described.

32582 (AED-Conf—75-773-000, pp 57-71) **State of material research concerning fuel rod behaviour in LWR loss-of-coolant accidents. The plastic behaviour of zircaloy-4 at higher temperature in air.** Bocek, M.; Petersen, C. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Apr 1976. (In German).

From Technical meeting of the Fachgruppe Brennelemente of the KTG; Erlangen, German, Federal Republic of (F.R. Germany) (14 Nov 1975).

12 figs.

In Safety aspects of LWR fuel rods.

When laying out an emergency cooling system, the deformation characteristics of fuel cans has to be known. In experimental investigations, some of the factors are examined which can influence the plastic behaviour of Zy-4 within the temperature range of loss-of-collant accidents (400-1,300 degrees C).

32583 (AED-Conf—75-773-000, pp 25-53) **Experimental investigations of the LWR fuel rod behaviour in loss-of-coolant accidents.** Cheliotis, G.; Weidinger, H.G. (Kraftwerk Union A.G., Erlangen (F.R. Germany)). Apr 1976. (In German).

From Technical meeting of the Fachgruppe 'Brennelemente' of the KTG; Erlangen, F.R. Germany (14 Nov 1975).

18 figs.; 7 refs.

In Safety aspects of LWR fuel rods.

The following investigations were made in experimental parameter studies: 1) Under which conditions does a fuel can burst, and 2) what is the interdependence between the fuel can expansion before bursting and the fuel rod loads of the emergency cooling system. The maximum expansions, in particular, were determined at given pressure, temperature, heat-up rate, and residence time.

32584 (AED-Conf—75-773-000, pp 75-88) **State of material research concerning fuel rod behaviour in LWR loss-of-coolant acci-**

dents. Investigations of the high-temperature water vapor oxidation. Leistikow, S. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Apr 1976. (In German).

From Technical meeting of the Fachgruppe 'Brennelemente' of the KTG; Erlangen, F.R. Germany (14 Nov 1975).

8 figs.; 2 refs.

In Safety aspects of LWR fuel rods.

The experimental investigations into the oxidation kinetics of zirkaloy 4 fuel cans of dimensions specific for PWRs were carried out mainly with the following tasks in mind: 1) Kinetic investigations of isothermal water vapor oxidation of unstressed can sections (900-1,300°C). 2) Kinetic investigations into the water vapor oxidation of unstressed can sections in temperature-transient, loss-of-coolant accident-like conditions. 3) Creep-rupture tests with tube capsules filled with pressurized inert gas and exposed to steam on the outside, in isothermal and temperature-transient model reactions. 4) Examination of the fuel cans exposed in the reactor under transient conditions in order to determine the degree of oxidation. 5) Use of the material parameters thus determined in a computer programme describing the material behaviour in loss-of-coolant accidents.

32585 (AED-Conf—75-773-001, pp 5-22) **Analysis of the loss-of-coolant accident in a LWR reactor with regard to its effects on the fuel rods.** Watzinger, H. (Kraftwerk Union A.G., Erlangen (F.R. Germany)). Apr 1976. (In German).

From Technical meeting of the Fachgruppe 'Brennelemente' of the KTG; Karlsruhe, Germany, F.R. (14 Nov 1975).

15 figs.

In Safety aspects of LWR fuel rods.

Analytic investigation of an accident according to the licensing provisions for PWRs and BWRs valid in the FRG at present.

32586 (ANL/RAS—76-34) **Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.** DeVolpi, A. (comp.). (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 351p. (CONF-761022—). Dep. NTIS $10.75.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

Papers are presented which deal with diagnostic requirements and fuel motion monitoring capabilities of hodoscopes, coded aperture systems, x-ray radiography, and in-core detectors. Separate abstracts and indexing were prepared for each paper. (DG)

32587 (ANL/RAS—76-34, pp 11p., Paper 1) **Ongoing experiments: diagnostics requirements.** Dickerman, C.E. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The paper reviews the fuel motion diagnostics needs for ongoing LMFBR safety experiments over approximately the next five years, with the discussion centered on TREAT. Brief comments on the direction in which clad motion diagnostics requirements are expected to develop are also presented.

32588 (ANL/RAS—76-34, pp 12p., Paper 3) **SAREF program.** Grolmes, M.A. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The paper summarizes the results of recent studies leading to recommendations on experiments and test facility requirements for fast breeder reactor safety. The role of in-pile experiments in support of the resolution of fast breeder reactor safety and liscensing issues has been re-examined, with emphasis on key safety issues. Experiment needs have been related to the specific characteristics of these safety issues and to realistic requirements for additional test facility capabilities which can be achieved and utilized within the next ten years. It is found that those safety issues related to the energetics of core disruptive accidents have the largest impact on new facility and diagnostic requirements. Emphasis has been placed upon maximum utilization of existing facilities and minimum requirements for new facilities. This evaluation has recommended that the essential elements of the Safety Research Experiment Facilities (SAREF) required for resolution of key issues include; a new Safety Test Facility, STF, major modifications to the EBR II facility, improvement in TREAT capabilities, and the existing Sodium Loop Safety Facility. Of the above, the new STF will play the largest role in experiments related to these key accident energetics safety issues and correspondingly requires the best state of the art in material motion diagnostic capabilities.

32589 (ANL/RAS—76-34, pp 3p., Paper 4) **Fuel- and clad-motion diagnostics: licensing needs.** Bari, R.A. (Brookhaven National Lab., Upton, NY); Meyer, J.F. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The paper addresses the current state of uncertainty with respect to fuel and clad motion during a hypothetical core-disruptive accident in a liquid metal fast breeder reactor as it relates to licensing needs. It should be noted that the paper does not represent an official position of the U.S. Nuclear Regulatory Commission, but rather, represents, in part, opinions and conclusions of its contractors. Particular attention is given to the needs for an assessment of the course of events during a hypothetical core-disruptive accident in the Clinch River Breeder Reactor. However, some of the issues discussed are likely to be relevant to larger breeder reactors as well. The issues addressed are related to the needs associated with analyses of the loss-of-flow (LOF) accident without scram and the transient overpower (TOP) accident, without scram.

32590 (ANL/RAS—76-34, pp 19p., Paper 14) **Flash-x-radiography for fuel motion studies.** Choate, L.M.; Halbleib, J.A. Sr.; Posey, L.D. (Kirtland Air Force Base, East Albuquerque, NM). 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The paper is primarily intended to be a status report on recent activities in the Flash X-ray Radiography/Cinematography area. Studies in the area of source definition as well as associated experimental limitations are discussed. The implications of machine current upon precision uncertainty in measurements of changes in areal density are presented. The radiographic techniques presently being evaluated are discussed. Performance estimates representative of this type of diagnostic tool are presented. Comparison with other results is made.

32591 (ANL/RAS—76-34, pp 9p., Paper 15) **Coded source x-radiography.** Kelly, J.G. (Sandia Labs., Albuquerque, NM). 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The coded source x-radiography technique may provide a means of using a broad area source to observe fuel motion with an adequate signal to noise ratio and spatial resolution in simulated core disruptive safety experiments. This is important because in certain proposed experiments as much as 10^6 watts/cm^3 of energy will be deposited in the fuel, and a relativistic electron beam accelerator may be the only source intense enough to overcome the driver core induced background in the object. These beams are large in area and would provide very poor resolution if the coded source technique were not available. Experiments have been conducted to test the feasibility of the method for x-radiography of fuel pin shaped objects at the 10 MeV HERMES II accelerator at Sandia Laboratories. With this device a 1 cm diameter lead rod has been imaged with .2 cm spatial resolution by a source 20 cm wide. Additional imaging experiments with improved coded source configurations are planned.

32592 (ANL/RAS—76-34, pp 9p., Paper 16) **Development of in-core directional neutron and gamma ray sensors for fuel motion detection.** Cox, S.A.; Beyerlein, R.A.; LeVert, F.E. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

In-core neutron and gamma ray detectors should have wide use in the LMFBR safety program. Both types of detectors are under development at ANL. Studies in the Argonne Thermal Source Reactor demonstrate directional sensitivity and threshold type behavior. The first field use of the detectors will be with the Sodium Loop Safety Facility program in early 1977.

32593 (ANL/RAS—76-34, pp 23p., Paper 17) **In-core fuel motion detection for large scale tests.** Wright, S.A.; Dupree, S.A. (Sandia Labs., Albuquerque, NM). 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

An experimental program to test the feasibility of making and unfolding in-core measurements of fuel motion has been initiated at Sandia. The experiment calls for instrumenting a 37-pin fuel bundle and exposing it to neutron pulses in the Sandia Pulsed Reactor SPR-III. Fuel motion will be simulated by mechanically adjusting the fuel

pins to create voids within the center of the bundle. A preliminary design of the experiment has been completed and analyses have been conducted on the application of ^{238}U and ^{235}U fission couple detectors to the experiment. Formulation of the unfolding problem has pointed out the necessity of carefully instrumenting the experiment to maximize the resolution of the mass measurement. Ultimately a measurement resolution of 100-200 g of fuel should be possible for this experiment. The experiment will provide a realistic test bed for obtaining practical experience in detector design and data reduction.

32594 (ANL/RAS—76-34, pp 13p., Paper 19) **Advances in clad blockage detection.** Fink, C.L.; DeVolpi, A.; Stanford, G. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The use of high energy (< 6 MeV) capture gamma rays as a means of detecting steel movement in a transient test has been investigated. Experimental results for steady state reactor operation indicate that this method is capable of providing a reasonably unique signature of steel. In addition, the signal-to-background ratio of an R-series 7-pin test capsule was measured to be approximately 0.6 for 1 cm^3 of steel. It is estimated that this value will permit a time-resolved steel detection capability of approximately 0.2 cm^3. Implementation of this method to the 122-cm hodoscope required a minimum of modifications, and preliminary results using this array support a steel detection capability at least to the level of blockage formation.

32595 (ANL/RAS—76-34, pp 30p., Paper 20) **Hodoscope in-situ radiography.** Rhodes, E.; DeVolpi, A.; Fink, C.; Stanford, G.; Stewart, R. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The fast-neutron hodoscopes at TREAT and proposed for STF can be adapted to perform high-resolution radiography, in addition to their role of time-resolved test fuel imaging. Time resolution may be traded for increased spatial resolution by remote motorized scanning of the collimator, simulataneous collection of data from the detector array over extended time intervals, and deconvolution of the data from the collimator response function. Calculations and analysis of initial scanning experiments at TREAT indicate that an acceptable level of fuel density resolution can be achieved for TREAT and STF in-situ radiography.

32596 (ANL/RAS—76-34, pp 6p., Paper 22) **Sodium void detection.** DeVlopi, A. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

The voiding of sodium coolant is a property of significant interest in the LMFBR safety program, largely because of sodium's positive reactivity coefficient and because of the consequences associated with a loss of flow. At present there are existing methods of inferring the general characteristics of boiling and dryout from instrumentation inserted within the test section. However, none of these methods provides either differential or universal coverage over the entire test region. The hodoscope has been optimized for detection of fuel motion and recently clad blockage accumulation. It may not be possible to detect sodium voiding with the same degree of detailed coverage afforded by the hodoscope, but it may be possible to achieve coarse space and time resolution by the method described.

32597 (ANL/RAS—76-34, pp 5p., Paper 23) **High-speed x-ray photography.** Mizuta, H. 1976.

From Fuel and clad motion diagnostics for LMFBR safety test facilities conference; Chicago, Illinois, United States of America (USA) (9 Oct 1976).

In Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities.

A brief report of work being done in Japan in the use of high-speed x-ray photography for out-of-pile experiments is given. A low-energy x-ray generator is being used to image out-of-pile LMFBR fuel motion caused by direct electrical heating. The x-ray tube supplies radiation at an applied potential of 140 kV and 3 mA anode current. The transmitted beam is recorded by a high-speed framing camera operating at 1500 fps and focussed at infinity. A single-frame image from the high speed camera is illustrated along with a better line resolution (but longer time resolution) TV monitor picture which shows details of the liquid-gas interface and the thermocouple shadows.

32598 (BMI-NUREG—1965) **Fission product transport analysis. Quarterly progress report, July—September 1976.** Jordan, H.; Baybutt, P.; Gieseke, J.A.; Denning, R.S. (Battelle Columbus Labs., Ohio (USA)). 30 Dec 1976. 19p. Dep. NTIS $3.50.

Fission products that escape to the environment during a hypothetical controlled loss-of-coolant accident (LOCA) in a light water reactor (LWR) are studied. It is the task of this project to provide an assessment of the penetration of the primary system envelope of a pressurized water reactor (PWR) and a boiling water reactor (BWR) and to assess the related fission product penetration of a failed spent fuel shipping cask. In doing so, reliance is placed on the development of a source term (i.e., the fission product penetration rate of the fuel cladding barrier) under a separate project at ORNL and indeed these two projects are closely coordinated. Efforts during this quarter were devoted almost exclusively toward completing the assembly of the TRAP preliminary code and debugging it. This report will therefore concentrate on highlighting some of the technical aspects of the code.

32599 (CEA-CONF—3546) **Blowdown experiments and interpretation.** Rousseau, J.C. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1975. vp. INIS.

From Annual meeting of the European two-phase flow group; Haifa, Israel (1 Jun 1975).

The CANON experiments which are being arried out in Grenoble are intended for providing data for the development of a new theoretical analysis programmed in a computer code named BERTHA, which will predict the hydrodynamic phenomena of a blowdown accident in a light water reactor. CANON experiments, carried out under adiabatic conditions, are a means of checking methods of pressure and temperature measurements. Presently, they allow the development of a new technique of measuring the mean void fraction in a section of the channel from epithermal neutron absorption, such measurements being made every one or two milliseconds. the BERTHA code is a one-dimensional model with the hypothesis of equal velocity of each phase, but taking into account a thermodynamic nonequilibrium. The energy flux at the phase interface is evaluated with a conduction model in the liquid layer at this interface. The numerical method used is a characteristic one. It is very slow as soon as the flow is in liquid phase, but it leads to an acceptable time-step in two-phase flow. Consequently, the method is well adapted to the problem of blowdown in which the fluid remains in liquid phase during a few milliseconds.

32600 (CEA-CONF—3566) **Experimental safety research for LMFBR's.** Kessler, G.; Teague, H.; Bailly, J.; Petit, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). 1976. 22p. INIS.

From International conference on advanced nuclear energy systems; Pittsburgh, Pa., USA (14 Mar 1976).

A survey is given of the Western European LMFBR safety research programs. Various joint in-pile experiments are carried out in support of theoretical analyses of local cooling failures and whole core accidents. The extent to which such accidents are covered by the present programs dealing with fuel failure processes is discussed. In addition to the comprehensive experience gained from these programs, a study of the possibilities of fuel bundle failure experiments in a fast test reactor and a design study for in-pile experiments on post-accident heat removal are recommended.

32601 (COO—2801-4) **Direct in-vessel applications experiments at Harvard Air Cleaning Laboratory. Progress report, July 1, 1976—September 30, 1976.** Mallove, E.F.; Hinds, W.C.; First, M.W. (Harvard School of Public Health, Boston, Mass. (USA)). Oct 1976. Contract EY-76-S-02-2801. 19p. Dep. NTIS $3.50.

Continuing research at Harvard Air Cleaning Laboratory on direct in-vessel emergency air cleaning systems for the LMFBR is described. The objective of these systems is to reduce the two-hour integrated dose leaking from a containment vessel by rapidly reducing the aerosol concentration within the containment. The reduction in concentration is achieved by direct action of the entire containment volume rather than by more conventional recirculating clean-up loops. A high concentration sodium aerosol test is described in which induced turbulent agglomeration dramatically enhances sedimentation and yields a two-hour dose reduction factor (DRF) of 56 for a 4 meter high vessel. Attempts to achieve DRF (2-hr.) greater than 10 by increasing the powder dispersal rate in aerosol scavenging tests are also described. It was found that a combination of systems operating simultaneously, i.e., induced turbulent agglomeration and powder scavenging, yielded better performance than either mechanism alone under identical sodium aerosol conditions. The construction of a pulse jet engine and acoustic transmission duct for irradiating a reverberant test cell with high intensity sound is described. Sound pressure levels up to 150 dB, sufficient to agglomerate dense aerosols, were demonstrated. A successful acoustic transmission method that prevented heat and exhaust gases from the jet from affecting the experimental aerosol is described. Plans for improving jet performance preparatory to full scale tests with sodium aerosols are discussed.

32602 (CREARE-TN—247) **Lower plenum voiding, periodic delivery behavior, and elevated pressure superheated wall tests at 1/15**

scale. Quarterly progress report, July 1, 1976—September 30, 1976. Block, J.A.; Crowley, C.J. (Creare, Inc., Hanover, N.H. (USA)). 19 Oct 1976. 53p. Dep. NTIS $4.00.

Results of experiments in a 1/15 scale, cylindrical elevated pressure PWR-model test vessel are described. These tests form part of a program to develop an analytical and empirical model for plenum filling. During the quarter, tests were performed of lower plenum voiding (LPV) (with water injection directly into the lower plenum) and of LPV with countercurrent flow (with injection into the cold legs). Equilibrium water levels (voiding levels) in each case are compared. Water delivery behavior with highly subcooled ECC in countercurrent flow tests was also explored. The effect of various parameters on the oscillatory delivery of water in these tests is discussed. Also discussed are the effects of elevated pressure on water delivery delay time and the results of scoping tests of countercurrent flow where the core steam supply is "soft" or coupled, that is, influenced by events taking place in the vessel.

32603 (GEAP—14034-8) **Radiological assessment models eighth quarterly report, June—August 1976 .** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Sep 1976. Contract E(04-3)-0893-TAS-15. 32p. AT.

This report, documenting progress during June, July, and August 1976, is the eighth in a series of quarterly reports published under the Radiological Assessments Program. The objectives of the program are to develop models for analyzing and evaluating postulated radiological sources, aerosol dynamics, sodium fires, and radiological dosages arising from hypothetical core disruptive accidents in liquid metal fast breeder reactors.

32604 (HEDL-SA—1119-FP) **Hydrogen formation and control under postulated LMFBR accident conditions.** Armstrong, G.R.; Wierman, R.W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-2170. 27p. (CONF-7609109—1). Dep. NTIS $4.00.

From Safety technology meeting on inherent retention; Bethesda, Maryland, United States of America (USA) (Sep 1976).

The objective of this study is to experimentally investigate the potential for autoignition and combustion of hydrogen-sodium mixtures which may be produced in LMFBR accidents. The purpose and ultimate usefulness of this work is to provide data that will establish the validity and acceptability of mechanisms inherent to the LMFBR that could either prevent or delay the accumulation of hydrogen gas to less than 4 percent (V) in the Reactor Containment Building (RCB) under accident conditions. The results to date indicate that sodium and sodium-hydrogen mixtures such as may be expected during LMFBR postulated accidents will ignite upon entering an air atmosphere and that the hydrogen present will be essentially all consumed until such time that the oxygen concentration is depleted.

32605 (IKE—2-30) **Analysis of physical processes in thermodynamic mixing reactions.** Brueckner, U.; Unger, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Apr 1973. 114p. (In German). NTIS (US Sales Only).

48 refs.; with figs.

A survey of the publications investigating the thermodynamic interaction between hot melts and supercooled water or liquid sodium is presented. The authors' own contribution is a calculation of upper limits for the mechanical energy released during the interaction between molten UO_2 and coolant (H_2O, Na). The fragmentation process of the melt is described in a time-dependent model. The model is based on the assumption that fragmentation is caused by the kinetic energy produced during the interaction between melt and coolant. A process of stepwise fragmentation due to collapsing steam bubbles is discussed, and the influence of the liquid flowing towards the drops of molten material on the fragmentation process is studied. 48 references.

32606 (INIS-mf—3148, pp 107-128) **Calculations of the consequences of a reactor accident initiated by meltdown, app. 6.** Stoute, J.R.D. (Stichting Reactor Centrum Nederland, Petten); Wisse, J.A. (Koninklijk Nederlands Meteorologisch Instituut, De Bilt). 3 Sep 1975. (In Dutch).

Published in summary form only.

In Nuclear power plants and public health, an advice by the Health Council.

32607 (INIS-mf—3224, pp 50-51) **Effect of flow blockage on reflooding behaviour in pressure-tube type reactor.** Kawamata, N.; Kitahara, T. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 4 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32608 (INIS-mf—3224, pp 46-47) **CORECOOL, a model for the temperature distribution and the two-phase flow in a fuel element under LOCA conditions.** Munthe Andersen, J.G. (Danish Atomic Energy Commission, Risoe. Research Establishment). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32609 (INIS-mf—3224, pp 89-90) **Experimental results of the interaction of molten core materials with concrete.** Dahlgren, D.A.; Powers, D.A.; Butcher, B.M.; Muir, J.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32610 (INIS-mf—3224, pp 35) **Volatile fission product behaviour in reactor fuel rods under accident conditions.** Forsyth, R.S.; Blackadder, W.B.; Nilsson, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32611 (INIS-mf—3224, pp 28-29) **CANSWELL: a computer-model of clad-behaviour during a loss of cooling accident.** Gittus, J.H.; Hindle, E.D.; Jones, P.M. (UKAEA Reactor Group, Springfields). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32612 (INIS-mf—3224, pp 97-98) **Application of the COMETHE code to LOCA analysis.** Hoppe, N.; de Meulemeester, E. (Societe Belge pour l'Industrie Nucleaire, Brussels). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 1 reference.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32613 (INIS-mf—3224, pp 102) **Verification of the finite element model FEMAXI against in-pile fuel rod diameter measurements.** Ichikawa, M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32614 (INIS-mf—3224, pp 30-31) **Zircaloy cladding diametral expansion during a LOCA - EDGAR programme.** Morize, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Recherches Metallurgiques Appliquees); Vidal, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Etudes Techniques de Surete). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor elements under accident conditions.

32615 (INIS-mf—3224, pp 56-69) **Out-of pile experiments on ballooning in zircaloy fuel rod claddings in the low pressure phase of a loss of coolant accident.** Erbacher, F.; Neitzel, H.J.; Riemann, M.; Wiehr, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 17 figs.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32616 (INIS-mf—3224, pp 40-42) **Computer simulation of fission gas behaviour during fast thermal transients.** Esteves, R.G.; Wazzan, A.R.; Okrent, D.; Griesmeyer, J.M.; Steele, W.G.; Chien, S.H. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 1 fig. and 6 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32617 (INIS-mf—3224, pp 33-34) **Fission product release from simulated LWR fuel.** Lorenz, R.A.; Collins, J.L.; Malinauskas, A.P.; Manning, S.R. (Oak Ridge National Lab., Tenn. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 2 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32618 (INIS-mf—3224, pp 118) **Sensitivity study on LWR fuel rod behaviour during loss of coolant accidents with SSYST MOD 1.** Meyder, R.; Raff, S.; Sengpiel, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32619 (INIS-mf—3224, pp 88) **Properties of LWR core melts.** Nazare, S.; Ondracek, G.; Schulz, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32620 (INIS-mf—3224, pp 36-39) **Developments and experimental verification of SST: a steady state and transient fuel response and fission product release code.** Rest, J.; Seitz, M.G.; Kelman, L.R.; Gehl, S.M. (Argonne National Lab., Ill. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 1 fig. and 8 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32621 (INIS-mf—3224, pp 112-114) **Reload fuel supplier's approach to modelling fuel behaviour for LWR LOCA analysis.** Sofer, G.A.; Merckx, K.R.; Steves, L.H.; Leach, C.E.; Rowe, D.S.; Galbraith, K.P. (Exxon Nuclear Co., Richland, Wash. (USA)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 7 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32622 (INIS-mf—3224, pp 73-77) **Temperature and cladding burst distributions in a PWR core during LOCA.** Burman, D.L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Fuel Div.); Olson, C.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Water Reactor Divisions). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 3 figs.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32623 (INIS-mf—3224, pp 119-120) **Preliminary sensitivity study on LOCA fuel/coolant heat transfer analysis using the THETA 1-B code.** Green, W.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32624 (INIS-mf—3224, pp 82-83) **Meltdown behaviour of fuel rods.** Hagen, S.; Malauschek, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 2references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32625 (INIS-mf—3224, pp 70-72) **LOCA-fuel rod behaviour of KWU-pressurised water reactors.** Weidinger, H.G.; Cheliotis, G.; Watzinger, H.; Stehle, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Reaktortechnik). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 2 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32626 (INIS-mf—3224, pp 19-20) **Swelling behaviour of SGHWR fuel cladding in steam in laboratory tests simulating LOCA involving temperatures above 900 deg. C.** Hindle, E.D.; Mowat, J.A. (UKAEA Reactor Group, Springfields). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only. 3 references.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32627 (INIS-mf—3224, pp 52-53) **Behaviour of SGHWR fuel elements under accident conditions.** Mann, C.H. (UKAEA Reactor Group, Springfields). [nd].

From The behaviour of water reactor fuel elements under accident conditions; Spaatind ;Norway: (13 Sep 1976).

In summary form only.

In Specialists' meeting on the behaviour of water reactor fuel elements under accident conditions.

32628 (LA-NUREG—6579-PR) **Reactor safety and technology. Quarterly progress report, July 1—September 30, 1976.** Lathrop, K.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1976. Contract W-7405-ENG-36. 103p. Dep. NTIS $5.50.

Safety research studies involving HTGR, LWR, LMFBR, and GCFR type reactors are summarized. (DG)

32629 (ORNL/NUREG/TM—64) **Heavy-section steel technology program. Quarterly progress report, July—September 1976.** Whitman, G.D. (Oak Ridge National Lab., Tenn. (USA)). 20 Dec 1976. Contract W-7405-ENG-26;NRC-INA-40-551-75. 99p. Dep. NTIS $5.50.

The program comprises studies related to all areas of the technology of the materials fabricated into thick-section, primary-coolant containment systems of light-water-cooled nuclear power reactors. The principal area of investigation is the behavior and structural integrity of steel pressure vessels containing cracklike flaws. Current work in the following tasks is described: fracture mechanics analyses and investigations, effect of high-temperature primary reactor water on the subcritical crack growth of reactor vessel steel, investigations of irradiated materials, pressure vessel investigations, and thermal shock investigations.

32630 (ORNL/NUREG/TM—66) **High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1, 1976—September 30, 1976.** Sanders, J.P. (Oak Ridge National Lab., Tenn. (USA)). 29 Nov 1976. Contract W-7405-ENG-26;NRC-INA-40-551-75. 33p. Dep. NTIS $4.00.

Progress is summarized in the following areas: analysis of rod-withdrawal transients in the Fort St. Vrain reactor; dynamic modeling of HTGR steam generators, including a nonlinear model for the Vrain steam generator-reheater; and evaluation of the Reactor Emergency Cooling Analysis (RECA) code. (DG)

32631 (ORNL/NUREG/TM—75) **LMFBR aerosol release and transport program. Quarterly progress report, July—September 1976.** Fontana, M.H.; Kress, T.S. (Oak Ridge National Lab., Tenn. (USA)). 11 Jan 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75. 35p. Dep. NTIS $4.00.

This report summarizes progress under the LMFBR Aerosol Release and Transport Program (sponsored by the Division of Reactor Safety Research of the Nuclear Regulatory Commission) for the period July-September 1976. The report discusses progress in design and construction of the ORNL capacitor discharge vaporization system CRI-III; fuel-simulant aerosol studies in the CRI-II facility, including a comparison of U_3O_8 and UO_2 aerosol behavior; progress in reactivation of the Nuclear Safety Pilot Plant (NSPP) for

sodium fire experiments; preapplication testing of aerosol characterization instruments for the NSPP; preliminary work for the fuel-aerosol simulation test (FAST); analytical studies of bubble transport behavior and bubble-expansion thermodynamics; and program coordination and planning of possible experiments on postaccident heat removal in the ORR.

32632 (ORNL/NUREG/TM—87) **Zirconium metal-water oxidation kinetics program sponsored by the NRC Division of Reactor Safety Research. Quarterly progress report, October—December 1976.** Cathcart, J.V. (Oak Ridge National Lab., Tenn. (USA)). 21 Jan 1977. Contract W-7405-ENG-26; NRC-INA-40-551-75; NRC-INA-40-552-75. 15p. Dep. NTIS $3.50.

The final report of the Reaction Rate Studies Task was essentially completed, and a set of conclusions and recommendations based on this work is presented. A comparison is made between the results of the current study and those of previous investigators, and the degree of conservatism of the Baker—Just correlation is estimated. The variation of the oxide-alpha thickness ratio with temperature is described, and progress in the Steam Pressure Effects Task is discussed.

32633 (ORNL/TM—5699) **LMFBR safety and core system programs progress report, April—June 1976.** Wantland, J.L. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Feb 1977. Contract W-7405-ENG-26. 122p. AT.

Progress is summarized in the following areas: program coordination, analysis and data evaluation, detection methods development, FFM facility operation, fuel pin simulator development, neutronics analysis of a disrupted core, centralized computer data base for LMFBR safety codes, and model evaluation of LMFBR radioactivity releases. (DG)

32634 (PB—256793) **Risk analysis for earthquake-induced ground failure by liquefaction.** Yegian, M.K.; Whitman, R.V. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). May 1976. 331p. (R—76-22). NTIS (US Sales Only) $10.00.

Also pub. as Seismic Design Decision Analysis-26.

A methodology is proposed to study the likelihood of ground failure by liquefaction. Two alternate probabilistic models are developed which consider the uncertainties present both in the methods of analysis employed and the parameters used. The first model is based on a new empirical method of analysis for liquefaction which employs earthquake magnitude and hypocentral distance. The second probabilistic model is based on a modified version of a current method of analysis for liquefaction. These two models are later incorporated into risk analyses for liquefaction. Following the proposed procedure for liquefaction risk analysis, the actual site of a nuclear power plant is studied and the results are presented in this thesis. (GRA)

32635 (RD/B/N—3715) **Frequency limitations on reactor release derived from radiological criteria.** Clarke, R.H. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). May 1976. 22p.p. NTIS (US Sales Only).

Acceptable frequencies are suggested with which a number of defined individual and collective dose criteria are met. This has enabled a relationship to be proposed between the frequency and any event leading to release of radioactive material and the dose commitment to the hypothetical individual at the site boundary. The philosphy developed is generally applicable, but in this instance it has been demonstrated for an SGHW Reactor located at Sizewell. The results are derived on the basis of an acceptable level of risk of fatality to the most exposed individual and the application of the methodology to other reactor types and sites is demonstrated.

32636 (SAND—76-5547) **Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract E(29-1)-789;NRC-ERDA. 386p. (CONF-751141—). Dep. NTIS $11.75.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

Twenty-six papers are included. A separate abstract was prepared for each paper. (DG)

32637 (SAND—76-5547, pp 19-46) **Experiment needs and measurement requirements.** Marchaterre, J.F. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A discussion is presented of in-pile testing needs associated with LMFBR core-disruptive accidents or potential initiators of core-disruptive accidents. (DG)

32638 (SAND—76-5547, pp 65-83) **Methods used and kind of results obtained in SCARABEE facility about fuel and clad motion diagnostics. Previsional development for SCARABEE N and CABRI facilities.** Bardy, J.; Manent, G.; Roche, L.; Tattegrain, A. (CEN, Cadarache, France). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Techniques are described for planned LMFBR loss of flow simulation studies using irradiated fuel (SCARABEE N program) and for LMFBR transient overpower studies using both fresh and irradiated fuel (CABRI program). (DG)

32639 (SAND—76-5547, pp 85-102) **Current developments in TREAT hodoscope technology.** De Volpi, A. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

The development of fuel motion monitoring is traced from its inception through present operation and into future programs. After noting the role of fuel motion studies in terms of safety assurance for the LMFBR, the history of in-pile fuel monitoring is reviewed. The operational record of the present TREAT fast neutron hodoscope is summarized with attention to various performance features. Development plans for the TREAT hodoscope are described in some detail. Application of the hodoscope has been considered for eight safety facilities other than TREAT. In addition, there is a possible role for fuel monitoring techniques to be extended to real-time ex-vessel core surveillance in operating reactors. Certain intrinsic strengths of the hodoscope technique for material monitoring are identified. The pattern of development may be characterized as an adaptation of several technologies to fit available requirements and resources.

32640 (SAND—76-5547, pp 165-175) **X-ray cinematography of fuel pin motion.** Halbleib, J.A. Sr. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A procedure is discussed which has been used to estimate imaging fluxes and imaging detector deposition rates in studies of the feasibility of employing x-radiography for observing fuel motion. A discussion is presented of the results of applying these methods to: (1) an in-tank configuration for an upgraded version of Sandia's Annular Core Pulsed Reactor for looking at one- and seven-pin test assemblies and (2) a potential SAREF configuration with experiments ranging from single pin to multiple subassemblies. A few general comments on the feasibility of x-ray cinematography of fuel pin motion are made.

32641 (SAND—76-5547, pp 177-192) **Source requirements for flash x-radiography diagnostics.** Posey, L.D. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Electron beam sources capable of being used for x-ray cinematography were evaluated with respect to their applicability for the detection of LMFBR fuel motion. In the study each source type was coupled with a common detector system in order to determine source requirements. The basis for this determination was the proposed experiment matrix for the ANL SAREF program. The experimental situations considered corresponded to partial, single, and multiple subassemblies and operating power densities of 250 watts/gm to 10^4 watts/gm. The electron beam source types considered were LINAC, Linear Induction Accelerator, and Relativistic Electron Beam Accelerator. The background (neutron and gamma) from the driver reactor core and the test assembly itself were found to be a very important factor in sizing the electron beam sources. It is possible, however, that through the use of selective filtering techniques, differentiation between signal and background may be enhanced. The results of this work indicate that the Linear Induction Accelerator should be able to satisfy most experimental requirements up to and including full subassembly test configurations. Reasonable resolution should be attained for these configurations although it will be determined to a substantial degree by the effects of photon buildup and scattering.

32642 (SAND—76-5547, pp 193-209) **Qualitative diagnostics of coolant and cladding motion during LMFBR safety experiments using intrinsic-junction thermocouples.** Spencer, B.W.; Holtz, R.E.; Testa, F.J. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

The paper describes the thermocouple techniques and test data which have provided experimental information about molten cladding behavior during the R-series LMFBR safety tests. The R-series is an on-going program of LMFBR safety experiments performed in the Transient Reactor Test (TREAT) facility. The purpose of the program is to provide experimental confirmation of modeling in accident analysis codes such as SAS. The R-series test apparatus provides a flowing-sodium system with hydraulic and thermal features characteristic of current LMFBR design, in which multi-pin bundles of full-size LMFBR fuel pins may be subjected to simulated LMFBR accident conditions. The initial mission of the program has been to perform tests related to the hypothetical unprotected loss-of-flow (LOF) accident for FFTF safety studies.

32643 (SAND—76-5547, pp 211-221) **Monitoring clad blockages.** De Volpi, A.; Fink, C.L.; Stewart, R.R. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

In the coolant channels of LMFBR fuel rod subassemblies, melting and accumulation of clad material may cause flow blockage. No method of detecting these effects during radiation transients has been implemented to date; however, studies indicate that the fast neutron hodoscope at TREAT can be modified to accomplish unambiguous clad blockage detection. The procedure, which has been tested for several years, consists of adding a gamma detection array in tandem with the hodoscope neutron detectors. The array would be biased at energies high enough to favor detection of capture gamma rays from the various components of steel in contrast to gamma rays from fission and other competing processes. Estimated volume sensitivity, under reasonable conditions, is about 0.2 cm^3 of steel.

32644 (SAND—76-5547, pp 279-287) **Coded aperture x-radiography.** Kelly, J.G. (Sandia Labs., Albuquerque, NM); McArthur, D.A.; Barrett, H.H. Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

An experiment is described that will be conducted on the Hermes II flash x-ray facility to determine if coded source aperture techniques can be employed to make efficient use of a broad area, high power x-ray beam with a hard photon spectrum while concurrently maintaining good spatial resolution and tomographic capability. If this can in fact be demonstrated, then quality x-radiography may be possible with this type of field emission accelerator. Although the x-ray intensity provided by these accelerators is unequaled and may be needed during peak power levels of reactor pulses testing fuel motion, an extended program to develop multipulse capability would be required.

32645 (SAND—76-5547, pp 312) **Evaluation of instrumentation and the development of models by pyrotechnic methods.** Cooper, P.W.; Kurowski, S.R.; McKenzie, J.M. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Although the simulation of fuel motion by pyrotechnic methods appears restricted to individual phenomena within an overall HCDA, the possible range of experiments extends all the way from single fuel pins, through energetic disassembly of the core, to compaction of the core. Preliminary experiments to mimic the pressure pulse within the fuel resulting from a prompt critical power transient are discussed.

32646 (SAND—76-5547, pp 313-321) **Possible material motion simulation system.** Brehm, R.L.; Himes, D.A. (Univ. of Arizona, Tucson). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Direct electrical heating (DEH) of oxide fuel has been used at several laboratories to simulate in-pile behavior at high temperature under both steady-state and transient conditions. The DEH offers the advantages of being a relatively simple, inexpensive, non-radioactive means of investigating those aspects of the fuel behavior which are thermally rather than neutronically dominated. Because of the volumetric Joule heating, the radial temperature distribution can be made to approximate relatively closely the corresponding distribution obtained in-pile through fission heating. It is proposed that this technique might be utilized to simulate fuel pin behavior during rapid transients and that these experiments might be of value in testing certain fuel motion diagnostic techniques.

32647 (SAND—76-5547, pp 323-331) **Analysis of in-core fuel motion detection.** Biggs, F.; Renken, J.H. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A plan has been devised for analyzing proposed experiments to determine the motion of fuel rods in a reactor test cavity from measurements of neutron fluxes at points inside the cavity. The plan is organized into four phases that are successively more expensive in manpower and computer costs. Encouraging results from an analysis of small-fuel configurations of simple geometric design have been obtained during the first phase of the study. The second phase is in progress and consists of detailed neutron transport calculations to determine if assumed fuel displacements of interest produce changes in the neutron fluxes at the detector locations that are significant compared to background levels. Preliminary results from this phase indicate that a detailed feasibility study in Phase 3 is justified for at least some of the experimental designs under consideration. The third phase involves the use of adjoint transport calculations to obtain "importance" functions to be used in the error-analysis option of the UNFOLD computer program so that the accuracy with which fuel motion can be unfolded from measurements during the initial part of the motion (near zero time) can be determined.

32648 (SAND—76-5547, pp 333-342) **Accuracy of fuel motion measurements using in-core detectors.** Dupree, S.A. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

An initial assessment has been made as to how accurately fuel motion can be measured with in-core detectors. A portion of this assessment has involved the calculation of the response of various detectors to fuel motion and the development of a formalism for correlating uncertainties in a neutron flux measurement to uncertainties in the fuel motion. Initially, four idealized configurations were studied in one dimension. These configurations consisted of (1) a single fuel-pin test using ACPR, (2) a seven fuel-pin test using ACPR, (3) a full subassembly (271 pin) test using a Class I ANL-type SAREF, and (4) a full subassembly plus six partial subassemblies (approximately 1000 pin) test using a Class III GE-type SAREF. It was assumed that melt would occur symmetrically at the center of the test fuel and that fuel would therefore disappear from the center of the geometry. For each case of series of calculations was performed in which detector responses were determined at several radial locations for the unperturbed core and for the core with various fractions of the fuel replaced with Na. This fuel loss was assumed to occur essentially instantaneously such that the power level in the remaining portion of the test fuel remained unchanged from that of the initial unperturbed condition.

32649 (SAND—76-5547, pp 343-352) **Fuel motion measurements with in-core detectors.** Edwards, L.R. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Two detection schemes which appear promising for in-core fuel motion monitoring in safety reactor facilities such as SAREF are described. The two types of detectors being considered are the diamond solid state ionization chamber and the fission couple. The pertinent physical properties of these detectors relative to their potential usage are discussed.

32650 (SAND—76-5547, pp 353-356) **Development of an in-core directional fuel motion monitor.** Cox, S.A.; Beyerlein, R.A.; LeVert, F.E. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A program has been undertaken at ANL to develop in-core instrumentation for fuel motion monitoring in connection with the Sodium Loop Safety Facility (SLSF) tests. Since the SLSF fuel bundle is to be inserted into a test hole in the Engineering Test Reactor (ETR), any monitor must be able to observe changes in flux from the fuel bundle in the presence of a large background flux from the ETR. A detector with directional sensitivity would enhance the signal from the fuel bundle. A detector with a threshold type behavior is also desirable in order to discriminate against the soft components of the neutron and gamma ray flux of the ETR. Current effort is concentrated in investigating the characteristics of two types of detector. The two detector types include a neutron detector which utilizes a hydrogenous layer as a proton recoil radiator, and a gamma ray detector which utilizes a thin lead layer advantage of the Z dependence of the photoelectric effect.

32651 (SAND—76-5547, pp 357-378) **Preliminary material motion assessment for SAREF.** Rose, D. (Argonne National Lab., IL). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

A description is provided of the basis for a comprehensive assessment of material motion for experiments in the Safety Research Experiment Facility (SAREF) that is being carried out, in which the projected capabilities of several instrumentation systems are to be compared against the requirements established by the desired experimental information. Preliminary requirements for fuel motion monitoring criteria are related to requirements for experiment interpretation and to analysis of postulated accidents. Preliminary projected capabilities are presented that focus on the initial emphasis of fuel motion assessment for the largest tests, particularly with respect to whether in-core detectors can achieve the desired capability, or whether devices requiring slots within the reactor core are essential. The conclusion from this initial effort is that a reasonable basis exists for expecting the hodoscope to satisfy the criteria for fuel-motion monitoring for these experiments in SAREF, while in-core detectors are likely to fall substantially short of meeting the requirement.

32652 (SRD-R—41, pp vp, Paper SNI 3/3) **Semiautomatic method for qualitative failure mode analysis.** Taylor, J.R. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A description is given of a formalised version of 'cause-consequence analysis' which is a diagrammatic technique for presenting the sequence of events leading to a failure and the conditions under which these events can take place. The methods described are directed especially to cases where sequence is important, particularly sequential controllers, computer control and checking of written operating procedures. The automation of diagram construction is described. A chemical dosing system and safety system is used to demonstrate the construction of a cause-consequence diagram. To make a complete cause-consequence analysis, event chains from both normal operational and failure events must be traced. If sequence is not significant the cause consequence diagrams can be condensed to a single failure tree.

32653 (SRD-R—41, pp vp, Paper SNI 3/32) **Present status of reliability study on nuclear power plants in Japan.** Togo, Y. (Tokushima Univ. (Japan). Faculty of Engineering). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

In Japan, the Sub-Committee on Reactor Safety and Reliability of Engineering Safeguards has been investigating a probabilistic approach and has conducted work on the reliability calculations of safety systems and on the standard risk for safety evaluation of a nuclear power plant. A summary is presented of recent activities which are concerned with the following: a reliability data collection including failure data on nuclear power plant components and also fundamental aviation data for investigation of aircraft crash accident; a method for deciding upon the design earthquake and determination of allowable stresses for a seismic design; pipe rupture problems in safety design of LMFBR type reactors; and finally with meteorological problems such as the selection of atmospheric diffusion parameters for safety evaluation.

32654 (SRD-R—41, pp vp, Paper SNI 3/2) **Influence of safety on control system design using a probability approach.** Wray, D. (Nuclear Power Group Ltd., Risley (UK)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

The basic principles of a probability approach to safety aspects of reactor control are explained. The method is then applied to the safety of a reactor control system under normal operation and also under automatic control, with particular reference to the SGHWR. Emergency conditions are considered and the probability principle is applied to the detection system, shut-down system and emergency cooling, in order to determine their reliabilities.

32655 (SRD-R—41, pp Paper no.SNI 3/7) **Progress towards probabilistic basis for deterministic codes.** Ellyin, F. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and applicatin of reliability techniques to nuclear plant.

Fundamental arguments for a probabilistic basis of codes are presented. A class of code formats is outlined in which explicit statistical measures of uncertainty of design variables are incorporated. The format looks very much like present codes (deterministic) except for having a probabilistic background. An example is provided whereby the design factors are plotted against the safety index, the probability of failure, and the risk of mortality. The safety level of the present codes is also indicated. A decision regarding the new probabilistically based code parameters thus could be made with full knowledge of implied consequences.

32656 (SRD-R—41, pp Paper no.SNI 3/22) **Multistep reliability analysis and optimization of complex systems.** Colombo, A.G.; Volta, G. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

The paper describes an approach for reliability analysis and optimization of complex systems. The approach is based on event-tree representation, cut sets analysis, bound approximation and sensitivity analysis. Reference is made to the methods and computer programs developed for various steps of the analysis. In particular, details are given for the sensitivity analysis and optimization. Examples of application to reactor scram systems and electrical supply systems are reported.

32657 (SRD-R—41, pp Paper no.SNI 3/25) **Principles of reliability assessment for computerized safety systems.** Hoermann, H.A. (Technische Univ. Muenchen (Germany, F.R.)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

Safety and reliability problem introduced by the use of computers in reactor protection systems are examined. The main functions of the computer for reactor protection are explained and the principle structures of computerised systems are described. The effects of faults in hardware components and in software are discussed. Various methods are then demonstrated for establishing acceptable reliability figures for the computerised functions within a reactor safety system and the principles are discussed in more detail in relation to German BWRs. It is concluded that the many new problems created by such use of computers require the development of new methods during the design and reliability analysis.

32658 (SRD-R—41, pp Paper no.SNI 3/4) **Availability analysis of supervised protective systems.** Kontoleon, N.; Kontoleon, J.M.;

Chrysochoides, N.G. (Democritus Nuclear Research Center, Athens (Greece)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

The behaviour in time of a nuclear reactor supervised protective system is modelled mathematically by a Markov process, continuous in time and with three discrete states. Failure and repair rates are assumed to be exponentially distributed. An analytical expression of system availability as a function of failure and repair rates as well as the inspection intervals and duration is derived. An optimization problem is then discussed in order to maximize system availability with respect to imposed cost constraints. Finally, an example of a supervised protective system with short inactive times is given, which may be found in many practical situations of modern protective systems.

32659 (SRD-R—41, pp Paper no.SNI 3/24) **Improvement of engineered safeguards availability by means of computerized inspection techniques.** Hawickhorst, W. (Technische Univ. Muenchen (Germany, F.R.)). Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

Investigations are described which are aimed at establishing possible improvements in availability of engineered safety systems by replacing manual procedures by process computer controls. Hybrid simulation is used to develop computerized checking procedures for analysing available input data by means of more sophisticated algorithms. The system to be supervised is represented by a simplified analogue model of one strand of a BWR core flooding loop. The performance and limitations of different identification routines are examined.

32660 (SRD-R—41, pp Paper no.SNI 3/18) **Results of the reliability analysis of the emergency core cooling system from the Gemeinschaftskernkraftwerk Neckar.** Boehm, B. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)); Blombach, J.; Rosehauer, W. Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

Licensing procedure in the German Federal Republic is based on a deterministic safety criteria: probability of incidents are not admitted for discussion. Reliability analysis is therefore restricted to subsystems. The analysis is described for the Neckarwestheim nuclear power plant, which has three main coolant loops. It is concluded that the appropriate reliability parameter for the assessment of the safety of the emergency core coolant system is the maximum value of the unavailability. It is also possible to demonstrate that for Neckar, by appropriate design, normal operation tasks can be transferred to the emergency cooling system. Moreover, a quantitative basis for the definition of allowable repair time can be given.

32661 (SRD-R—41, pp Paper no.SNI 3/10) **Evaluation of safeguards reliability - containment spray.** Gangloff, W.C.; Sarver, S.J.; Franke, T. Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A fault tree analysis of a typical containment spray system has been performed by Westinghouse. The fault tree analysis combines the random component failures in the correct logical manner to arrive at system failure. The various component failure probabilities taken in the necessary combination, result in a system failure probability which then may be judged as a characteristic of system performance. An interesting feature of this particular system, which gives rise to certain problems not encountered in other safeguards systems, is the undesirability of inadvertant operation. The system design represents a compromise between reliability in the usual sense and reliability against spurious operation. The final adequacy of the system must then be judged by two figures of merit rather than merely the accident performance. Results of the fault tree analysis have shown that it is possible to achieve system design which satisfies both constraints in a reasonable manner.

32662 (SRD-R—41, pp Paper no.SNI 3/31) **Use of reliability analysis techniques applied to nuclear power station emergency core cooling systems.** Danielsen, A.; Snaith, E.R. Jan 1975.

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of reliability techniques to nuclear plant.

A reliability investigation carried out by the Safety and Reliability Services of the UKAEA, and the SSEB, of the essential system/reactor coolant system for a large nuclear power station is described. In AGR type reactors, after all reactor shutdown conditions, it is necessary to restore forced gas circulation and sufficient boiler feed to maintain the heat removal capacity of the boilers. The coolant requirements are provided by several independent mechanical systems of primary coolant fans, feedwater pumps, and valves integrated with electrical power sources, switchgear, and automatic control equipment. Reliability is treated as one aspect of system performance and quantified in terms of failure to meet a specific objective. Based on the reliability performance of the constituent components the optimum system configuration is determined together with the preferred plant operating procedures and maintenance requirements.

32663 (SRD-R—41, pp Paper no.SNI 3/14) **Use of small on-line computers for fast reactor protection systems.** Grisollet, J.; Quenee, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Jan 1975. (In French).

From Specialist meeting on the development and application of reliability techniques to nuclear plant; Liverpool, UK (8 Apr 1974).

Available from Safety and Reliability Directorate, U.K.A.E.A., Wigshaw Lane, Culcheth, Warrington, WA3 4NE, price Pound15.00.

In Specialist meeting on the development and application of eliability techniques to nuclear plant.

The large number of physical measurements to be taken into account to assure the protection of fast reactors poses problems which can be solved only by computers. After the presentation of existing French installations, standards are analysed from the point of view of reliability-availability. For this purpose small industrial calculators restricted to the protective function assigned to them are the most suitable in the present state of the technology. Experience acquired and reliability data give a quantitative confirmation of the 'small on-line computers with a protective function' option. The desirability of a test policy intended to improve the reliability of the system is examined in the light of this experience. From these considerations the most satisfactory new structure for meeting the present requirements in relation to the protection system is derived.

32664 (TREE-NUREG—1004) **Quarterly technical progress report on water reactor safety programs sponsored by the Nuclear Regulatory Commission's Division of Reactor Safety Research, April—June 1976.** (Idaho National Engineering Lab., Idaho Falls (USA)). Oct 1976. Contract EY-76-C-07-1570. 117p. Dep. NTIS $6.00.

Light water reactor safety research performed April through June 1976 is discussed. Results of a reflood heat transfer test series were analyzed to determine the reflood heat transfer characteristics of the Semiscale Mod-1 electrically heated core. A special test to investigate the sensitivity of departure from nucleate boiling to a change in core behavior was conducted with the Semiscale Mod-1 facility. Two loss-of-coolant experiments, including an investigation of hot-wall delay effects, were conducted in LOFT. Preliminary results for the PCM-2 and IE-1 Tests in the Power Burst Facility and postirradiation examination results from the IE-ST-1 and IE-ST-2 Tests are given. Model development activities include continued development of RELAP4/MOD6, development of a two-velocity thermal equilibrium flow model, and development of BEACON code mixed-dimensional multiregion coupling and equation-of-state routine for water. LOCA analysis verification activities consisted of studies of WHAM code modeling and uncertainty analysis methods for a LOCA analysis computer code. Fuel behavior verification efforts concentrated on a UO_2 and mixed-oxide swelling model, uncertainties in the expressions for cladding expansion and specific heat, modification of the zircaloy plastic deformation model, and analysis of results from steady state axial gas flow experiments utilizing PWR rods with argon and helium gases. As part of the industry cooperative effort, RELAP4 calculations were compared

with separate effects jet pump data from the General Electric Company two-loop test apparatus.

32665 (TREE-NUREG—1038) **Power-cooling-mismatch test series: test PCM-2 test results report.** Martinson, Z.R.; McCardell, R.K. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1977. Contract EY-76-C-07-1570. 181p. Dep. NTIS $7.75.

The report describes the results of an in-pile experimental investigation of pre- and postcritical heat flux (CHF) behavior of four 0.91-metre-long, pressurized water reactor (PWR) type, UO_2-fueled, zircaloy-clad fuel rods. The nominal coolant conditions for pressure and temperature were representative of those found in a commercial PWR. Eight separate departure from nucleate boiling (DNB) cycles were performed by decreasing the coolant flow rate while the fuel rod peak powers were held constant at about 46 kW/m. Two of the four fuel rods reached DNB conditions during all eight cycles, while one of the other two fuel rods reached DNB in all except the first cycle. The fourth fuel rod reached DNB only during the final cycle. For all except the final cycle, the test fuel rod powers were decreased as soon as DNB occurred. For the final cycle, the test fuel rods were allowed to remain in film boiling for over 60 seconds. All four fuel rods remained intact throughout the test. Results of the on-line measurements of the behavior of the fuel rods are presented together with a discussion of instrument performance. A comparison of the data with Fuel Rod Analysis Program—Transient (FRAP-T) computer code calculations is included.

32666 (ORNL-tr—4266) **Nuclear power plants: how dangerous are they.** Translated by E.G. Silver from *Bild Wiss.;* **11**: No. 3, 82-106(Mar 1974). 32p. Dep. NTIS $4.00.

Representatives of the responsible federal ministries, science, industry, and the citizen initiatives here discuss the radiation pollution in the vicinity of a nuclear power plant, the risk of living close to a nuclear plant, and the threat of a "radioactive accident".

32667 (EURFNR—1335) **Fast Breeder Project. Fourth quarterly report, 1975.** (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1975. Translation of KFK—1275/4. 245p. Dep. NTIS $8.00.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Progress is reported in fuel rod development, material investigations, corrosion studies, safety studies, and sodium technology.

32668 **Passive containment system for a nuclear reactor.** Kleimola, F.W. (to Nucledyne Engineering Corp.). US Patent 3,984,282. 5 Oct 1976. Filed date 30 Jul 1973. 24p.

A containment system is described that provides complete protection entirely by passive means for the loss of coolant accident in a nuclear power plant and wherein all stored energy released in the coolant blowdown is contained and absorbed while the nuclear fuel is continuously maintained submerged in liquid. The primary containment vessel is restored to a high subatmospheric pressure within a few minutes after accident initiation and the decay heat is safely transferred to the environment while radiolytic hydrogen is contained by passive means.

32669 **Safety requirements for nuclear power stations. VIII. Quality testing.** Schulz, H. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (Germany, F.R.). Gruppe Festigkeit und Werkstoffe). *Atomwirtsch., Atomtech.;* **21**: No. 11, 2-4(Nov 1976). (In German).

1 fig.

Tests for the observance of the specific material properties and production parameters and for accuracy to size, leak tightness, and load are presented.

32670 **Transient heat transfer between hot metal spheres and subcooled water.** Farahat, M.M.; Armstrong, D.R. (Argonne National Lab., Ill. (USA)); Eggen, D.T. (Northwestern Univ., Evanston, Ill. (USA)). *Atomkernenergie;* **29**: No. 1, 17-22(1977).

12 figs.; 13 refs.

Boiling heat transfer during interaction of hot metal spheres and subcooled water is investigated in the context of nuclear reactor safety. Stainless-steel spheres at high temperatures are quenched in a subcooled water pool and the sphere surface temperature is continuously monitored. Pressure pulses resulting from the vapour generation and collapse are also measured, allowing an accurate identification of the various boiling regimes particularly the chaotic transition boiling region. The range of variables investigated is: sphere diameter 2.54 cm; sphere initial temperature 450°C to 800°C; water temperature 23°C to 90°C; sphere depth in water 10.2 cm; pool pressure atmospheric. The data reduction technique used produced the full boiling curves of water under transient conditions. The obtained results indicate the importance of water subcooling in enhancing the energy transfer from the spheres to the coolant. Correlations are obtained for the minimum temperature difference in film boiling and for the critical heat flux as functions of water subcooling.

32671 **Safety of a commercial fast reactor. Chapter 3.** Farmer, F.R. (UKAEA Reactor Group, Culcheth). pp 59-66 of In Nuclear reactors. To breed or not to breed. Rotblat, J. (ed.). London; Taylor and Francis (1977).

The concept of 'safety' is discussed in relation to various aspects of fast reactor design and operation, and in relation to other industrial processes and real situations. Reactor control and shutdown, heat removal, core collapse, possible rate of increase of reactivity in an accident condition, transient loading of reactor components and surrounding structures, and interaction of fuel and coolant are considered.

ACCIDENT LIABILITY

32672 **Insurance risk of nuclear power plant concentrations. Two and more nuclear power plants on a single site.** Feldmann, J. (Allianz Versicherungs-A.G., Muenchen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **21**: No. 12, 575-576(Dec 1976). (In German).

The limited number of sites available in the Federal Republic of Germany for the erection of nuclear power plants has resulted in the construction of multiple nuclear generating units on a few sites, such as Biblis, Gundremmingen and Neckarwestheim. At a value invested of approximately DM 1,200/kW this corresponds to a property concentration on one site worth DM 2 - 3 billion and more. This raises the question whether a concentration of value of this magnitude does not already exceed the limits of bearable economic risks. The property risk of a nuclear power plant, as that of any other industrial plant, is a function of the property that can be destroyed in a maximum probable loss. Insurance companies subdivide plants into so-called complex areas in which fire damage or nuclear damage could spread. While in some foreign countries twin nuclear power plants are built, where the technical systems of both units are installed in one building without any physical separation, dual unit plants are built in the Federal Republic in which the complexes with a high concentration of valuable property are physically separate building units. As a result of this separation, property insurance companies have no grounds for assessing the risk and hence, the premium different from those of single unit plants.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 32730

MAGNETIC

REFER ALSO TO CITATION(S) 32971

COMPRESSED GAS

32673 **Hydride compressor.** Powell, J.R.; Salzano, F.J. (to Energy Research and Development Administration). US Patent Application 646,703. 5 Jan 1976. 14p.

A method of producing high energy pressurized gas working fluid power from a low energy, low temperature heat source is described. The compression energy is gained by using the low energy heat source to desorb hydrogen gas from a metal hydride bed and the desorbed hydrogen for producing power is recycled to the bed, where it is re-adsorbed, with the recycling being powered by the low energy heat source. In one embodiment, the adsorption-desorption cycle provides a chemical compressor that is powered by the low energy heat source, and the compressor is connected to a regenerative gas turbine having a high energy, high temperature heat source with the recycling being powered by the low energy heat source.

FLYWHEELS

REFER ALSO TO CITATION(S) 32787, 32788, 32789

THERMAL

REFER ALSO TO CITATION(S) 32254, 32768

32674 **Hydride heat pump.** Cottingham, J.G. (to Energy Research and Development Administration). US Patent Application 657,519. 12 Feb 1976. 8p.

A method and apparatus for the use of hydrides to extract heat from one temperature source and deliver the thermal energy extracted for use at a higher temperature, thereby acting as a heat pump are described. For this purpose, there are employed a pair of

hydridable metal compounds having different characteristics working together in a closed pressure system employing a high temperature source to upgrade the heat supplied from a low temperature source.

32675 Electric heater utilizing a pourable heat storage bulk. Erb, G.O. US Patent 3,989,927. 2 Nov 1976. Priority date 5 Aug 1972, German, Federal Republic of (F.R. Germany). 10p.

A storage heater for heating a gaseous heat extraction medium is formed of a container of heat resistant material, preferably metal. At least one guide duct, in the form of a tube for carrying the gaseous heat extraction medium, extends through the container which holds a heat storage medium in the form of a pourable bulk of particulate solid material. The thermal storage medium comprises a bulk in which the product of specific heat of the solid material and the bulk density of the mass is at least 0.7 kcal/°C dm^3, the specific heat of the solids material being at least 0.12 kcal/°C kgf and the bulk density of the solids material being at least 2.5 kgf/dm^3. The thermal storage medium is a material which can be in direct contact with the air to be heated for places of human habitation.

SOLAR ENERGY

RESOURCES AND AVAILABILITY

32676 Thermal energy storage using sodium sulfate decahydrate and water. Biswas, D.R. (Univ. of California, Berkeley). *Sol. Energy;* **19**: No. 1, 99-100(1977).

It appears that the major problem preventing use of sodium sulfate decahydrate for thermal energy storage can be avoided by using the composition which is at or slightly to the water-rich side of the invariant point in the phase diagram. A mixture of 68.2 w/o $Na_2SO_4 \times 10H_2O$ and 31.8 w/o H_2O is suggested for a TES material. (WDM)

ENERGY STORAGE

ENERGY STORAGE

THERMAL

REFER ALSO TO CITATION(S) 25090232690

32677 Heat or thermal energy storage structure. Best, J.S.; McMillan, W.J. (to Dow Chemical Co.). US Patent 4,003,426. 18 Jan 1977. Filed date 8 May 1975. 6p.

A heat or thermal energy storage structure comprising a crosslinked polymeric resinous matrix having a plurality of substantially unconnected small closed cavities and a heat sink material encapsulated within the cavities is described. The structure is characterized in that the heat sink material forms an essentially stable dispersion in the uncured polymeric resinous matrix when mixed therewith before the matrix is crosslinked. The structure can beneficially be used in conjunction with low level heat or thermal energy collector means and heat transfer means to provide a space heating or cooling apparatus. The storage structure may also be effectively used to provide an additional function of a building component in a building construction such as a wall structure.

32678 Thermal energy storage and utilization system. Cahn, R.P. (to Exxon Research and Engineering Co.). US Patent 4,003,786. 18 Jan 1977. Filed date 16 Sep 1975. 22p.

The power output from a nuclear power plant or fossil fuel power plant operating under constant reactor (or furnace) and boiler conditions is varied by regulating the rate of turbine extraction steam and primary high pressure steam used to heat boiler feed water (BFW). During periods of low power demand excess extraction steam is drawn off to heat excess quantities of boiler feed water. One portion of the BFW is fed to the boiler while the other portion is used to reheat a low vapor pressure (LVP) organic material which is stored under an inert atmosphere at atmospheric pressure in a high temperature storage location means. During periods of high power demand BFW preheat duties would be taken over entirely by the moving LVP organic material, moving from hot to cold storage location means, use of extraction steam for BFW reheat being curtailed and such untapped extraction steam being allowed instead to expand itself fully in the turbines. The boiler at all times receives a constant amount of uniformly preheated BFW.

32679 Storage heater bricks. Eadie, G.C.; Hinsley, C.F. (to British Steel Corp.). US Patent 4,006,734. 8 Feb 1977. Filed date 26 Nov 1974. 6p.

A heat storage medium is described that is produced by heating a mix of ferric oxide and an additive comprising a calcium compound to a temperature at which the additive reacts with the ferric oxide to improve its volumetric heat capacity, reducing the reaction product to particulate form, compacting the resulting particles, and sintering the compact.

BATTERIES

DESIGN AND DEVELOPMENT

32680 Secondary battery with separate charge and discharge zones. Ludwig, F.A. (to Ford Motor Co.). US Patent 3,994,745. 30 Nov 1976. Filed date 30 Jan 1976. 22p.

A secondary battery has the following components: discharge and charge zones containing alkali metal/sulfur cells, the cells in the discharge zone being adapted to operate in a discharge mode and having an electrode which is more readily wet by molten sulfur than by molten polysulfide salts of the alkali metal, and the cells in the charge zone being adapted to operate in a charge mode and having an electrode which is more readily wet by molten polysulfide salts of the alkali metal than by molten sulfur; a storage zone adapted to store molten sulfur and molten polysulfide salts from the cells; means for transporting reactant materials including molten sulfur and molten polysulfide salts of the alkali metal between the storage zone and the charge and discharge zones; and means for transporting molten alkali metal from the charge zone to the discharge zone. 7 figures.

32681 Vehicle storage battery cell. Trippe, G.; Brinkman, J. (to Varta Batterie Aktiengesellschaft). US Patent 3,996,065. 7 Dec 1976. Priority date 12 Nov 1973, German, Federal Republic of (F.R. Germany). 4p.

The plates of lead storage battery cells are supported at least from the top by resilient means attached to the cell cover. They may also be supported by resilient means from the cell bottom. The respective resilient means are placed diagonally relative to each other. At least the bottom support means has variable resiliency depending on the external forces applied to the cell. 3 figures.

32682 High voltage organic electrolyte batteries. Dey, A.N. (to P. R. Mallory and Co. Inc.). US Patent 3,998,658. 21 Dec 1976. Filed date 31 Jan 1975. 4p.

The solubility and reactivity of CrO_3 with the commonly used nonaqueous organic electrolytes used for high-voltage electrochemical cells is overcome by forming an intercalation compound of CrO_3 with graphite. The cathodes of such intercalation compounds, methods of making them, and cells containing such electrodes are described. In addition, it was found that cells containing such CrO_3 cathodes are readily rechargeable, and thus provide an excellent secondary battery. 3 figures.

32683 System for improving charge efficiency of a zinc-chloride battery. Berman, A.M.; Walker, R.C.; Aller, D.J. (to Energy Development Associates). US Patent 4,001,036. 4 Jan 1977. Filed date 20 Nov 1975. 6p.

A system is provided for improving the charge efficiency of a zinc—chloride battery by reducing the chlorine concentration on charge in a flowing electrolyte system by desorbing chlorine from the flowing electrolyte under reduced pressure and removing the desorbed chlorine from the electrolyte flow loop.

32684 Lead batteries. Beck, F. (to Badische Anilin- and Soda-Fabrik Aktiengesellschaft). US Patent 4,001,037. 4 Jan 1977. Priority date 3 Sep 1971, German, Federal Republic of (F.R. Germany). 6p.

Lead batteries which contain lead salt solutions and/or their corresponding acids and have a titanium base plate on the positive electrode and a graphite base plate on the negative electrode are described.

32685 Hermetic alkaline storage battery. Winsel, A.; Buder, E. (to Varta Batterie Aktiengesellschaft). US Patent 4,003,754. 18 Jan 1977. Priority date 7 Nov 1974, German, Federal Republic of (F.R. Germany). 6p.

Alkaline storage battery cells having negative electrodes with higher capacity than the positive electrodes are discussed. The positive electrodes have discharge-limiting capacity. The negative electrodes have additive of Raney metal, or Raney metal alloy, such cells constituting a battery.

32686 Rechargeable electrochemical cell. Briggs, D.C.; Hass, R.J. (to Aeronutronic Ford Corp.). US Patent 4,004,067. 18 Jan 1977. Filed date 7 Jun 1976. 6p.

A rechargeable electrochemical cell is disclosed which includes both a cathode and a gas-generating and consuming anode housed within a closed container. A storage volume is provided within the container for storing the gas used by the cell. A capillary mat lining material is provided throughout the gas storage volume of

the cell. This lining material is in liquid-transfer contact with a separator and electrolyte storage material located between the electrodes of the cell. If any electrolyte (i.e. water) of the cell is vaporized into the gas storage volume, the electrolyte will condense on the lining material and be conducted back to the separator and electrolyte storage material positioned between the electrodes.

32687 Electrochemical cell of a rechargeable nature. Briggs, D.C.; Hass, R.J. (to Aeronutronic Ford Corp.). US Patent 4,004,068. 18 Jan 1977. Filed date 7 Jun 1976. 6p.

A rechargeable electrochemical cell is disclosed which includes both a cathode and a gas-generating and consuming anode housed within a closed container. A closed volume is provided within the container for storing the gas used by the cell. A separator and electrolyte storage material is located between the electrodes of the cell. A reservoir is formed of a material capable of storing electrolyte. This reservoir is in liquid-transfer contact with the separator and electrolyte storage material between the electrodes. If any electrolyte of the cell stored in the separator and electrolyte storage material is vaporized into the gas storage volume, such electrolyte is replaced by transfer of electrolyte from the reservoir to the separator and electrolyte storage material.

PERFORMANCE AND TESTING

32688 (AD—A032299) **A review of materials and mechanisms which affect the performance of lead—acid storage batteries. Interim report Jun—Sep 76.** Perkins, J.; Pokorny, J.L.; Coyle, M.T. (Naval Postgraduate School, Monterey, Calif. (USA)). Oct 1976. 71p. (NPS—69PS76101). Q 04/MF/A01.

Principles governing the performance of the various materials used in contemporary lead—acid storage batteries are reviewed. It is shown how basic developments in materials science and electrochemical technology have led to substantial improvements in this well-established engineering system. The recent use of sophisticated microanalytical techniques to study battery plate behavior has contributed considerable insight into the mechanisms affecting performance under various conditions. These results are reviewed, and their relevance to service behavior is emphasized. The interrelationships between the various component materials of lead—acid systems — grid alloys, active material compounds, polymeric separators, and conductors and containers — are considered. (auth)

32689 Apparatus and method for separating the constituents of lead—acid storage batteries. La Point, A.E. US Patent 3,892,563. 1 Jul 1975. Filed date 14 May 1973. 10p.

A process for reclaiming active constituents of discarded lead—acid batteries is described. Shredded batteries, along with sodium carbonate and water, are directed into a rotating drum separator. After agitation and break-up, the battery constituents are separated, organic material floating in the slurry being removed, the heavier particles sinking to the bottom. These particles are then further separated by size by use of screens. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 32680, 32682, 32684, 32753

32690 (AD—A032298) **Microstructural comparison of positive float and trickle discharge operations on the positive electrodes of submarine storage batteries with lead—calcium alloy grids. Master's thesis.** Coyle, M.T. (Naval Postgraduate School, Monterey, Calif. (USA)). Sep 1976. 176p. Q 09/MF/A01.

Lead—calcium alloy grid batteries are utilized as the backup emergency power supply on non-Diesel-electric submarines. Sudden and premature capacity losses have been experienced when these batteries are operated in a float mode while in standby conditions, hence a continuous drain, or trickle discharge, is maintained in lieu of float. This requires periodic battery charges to restore full capacity. The microstructural effects of float and trickle discharge operation on positive plates from small cells, manufactured from full size submarine battery plates, are studied using a scanning electron microscope. This is complemented with light microscopy observations and x-ray diffraction analysis. A patterned dendritic network of spiny crystals was discovered to be prevalent in the trickle-discharged plates. This network was seen on the grid surface corrosion layer and on a dense layer found in the internal active material. It is postulated that this network may be related to lead sulfate dissolution upon recharge. (auth)

32691 Iron electrode. Giles, R.D. (to International Nickel Co., Inc.). US Patent 3,898,098. 5 Aug 1975. Priority date 21 Jun 1971, United Kingdom of Great Britain and Northern Ireland (UK). 5p.

A method for preparing electrodes for use as iron—nickel battery anodes is described. The active mass is electrodeposited from an aqueous electrolyte. (RWR)

32692 Vent valve for nickel—cadmium energy cells. Decker, A.S.; Stephenson, R.F. (to Motorola, Inc.). US Patent 3,994,749. 30 Nov 1976. Filed date 21 Aug 1975. 4p.

A vent valve for electric energy cells requiring pressure relief capability for gases formed within the cells due to overcharging or other circumstances includes a cover plate for the internal structure of the cell which contains a central relief aperture. A vent cap is affixed to the cover plate with one or more vent ports being provided. A resilient seal is provided between the vent cap and the cover plate for controlling the release of the gases, the seal being die-cut of a suitable corrosion-resistant material and having two parallel plane surfaces which contact the cover plate and the closed end of the vent cap when the cap and plate are joined. The seal is preferably of a polygon configuration and its vertices contact the walls of the cap for fixed positioning. The vent path for the gases is through the aperture in the cover plate, between the cover plate and the resilient seal, and out through the vent ports. 3 figures.

32693 Secondary battery or cell. Gupta, N.K.; Ludwig, F.A. (to Ford Motor Co.). US Patent 4,002,806. 11 Jan 1977. Filed date 20 Aug 1975. 14p.

This invention concerns an improved secondary battery or cell of the type having one or more anodic reaction zones containing a molten alkali metal reactant-anode in electrical contact with an external circuit, one or more cathodic reaction zones, and a cation-permeable barrier to mass liquid transport interposed between and in contact with the anodic and cathodic reaction zones. The cathodic reation zone(s) contains a cathodic reactant and an electrode of porous conductive material which is at least partially immersed in the cathodic reactant. When the battery or cell is in the theoretically fully charged state, the cathodic reactant consists of sulfur; when it is at least partially discharged, the reactant consists of a single-phase composition comprising a molten polysulfide salt of the anodic reactant or a two-phase composition comprising molten sulfur and molten sulfur-saturated polysulfide salts of the anodic reactant. The above-mentioned porous, conductive material is in electrical contact with both the cation-permeable barrier and an external circuit. The improvement comprises increasing the charge/discharge capacity of the battery or cell by including in the cathodic reactant controlled amounts of certain metals, alloys comprising such metals, salts of these metals, and oxides of these metals. 4 figures, 1 table.

32694 Alkali metal, sulfur battery or cell with single phase sulfur electrode. Ludwig, F.A. (to Ford Motor Co.). US Patent 4,002,807. 11 Jan 1977. Filed date 30 Sep 1975. 10p.

This invention concerns an improved secondary battery or cell of the type having one or more anodic reaction zones containing a molten alkali metal reactant-anode in electrical contact with an external circuit, one or more cathodic reaction zones, and a cation-permeable barrier to mass liquid transport interposed between and in contact with the anodic and cathodic reaction zones. The cathodic reaction zone(s) contains a cathodic reactant and an electrode of porous conductive material which is at least partially immersed in the cathodic reactant. When the battery or cell is in the theoretically fully charged state, the cathodic reactant consists of sulfur; when it is at least partially discharged, the reactant consists of a composition comprising a molten polysulfide salt of the anodic reactant or a composition comprising molten sulfur and molten sulfur-saturated polysulfide salts of the anodic reactant. The above-mentioned porous, conductive material is in electrical contact with both the cation-permeable barrier and an external circuit. The improvement comprises increasing the charge/discharge capacity of the battery or cell by dissolving in the cathodic reactant an additive which comprises either an element which will react with molten sulfur to form a polysulfide salt which is soluble in and forms a liquid solution with both sulfur and alkali metal polysulfide salts or a polysulfide salt of the element which is soluble in and forms a liquid solution with both sulfur and alkali metal polysulfide salts. 1 figure.

32695 Electrochemical cell. Fafa, J. (to Compagnie Industrielle des Piles Electriques Cipel). US Patent 4,002,808. 11 Jan 1977. Priority date 26 Feb 1974, France. 6p.

The invention relates to electrochemical cells intended to be electrically connected in series. Such a connection is obtained by means of a mechanical link between the terminals of opposite polarities of two adjacent cells. That mechanical link may be formed by a spring-catch system, screwing, or locking. The invention applies more particularly to cylindrical electric cells.

32696 Electrode structure for electrical energy storage device. Hall, J.C. (to Rockwell International Corp.). US Patent 4,003,753. 18 Jan 1977. Filed date 15 Mar 1976. 14p.

A rechargeable electric energy storage device includes a negative electrode, a positive electrode, and an electrolyte. At least one electrode includes a plurality of wall members, forming a plurality of cells having a certain open cross-sectional area. A substantially planar electrolyte-permeable member is affixed to the wall members and covers the open end of the cells, and a body of electrochemically active material is in the cells. The active material is a solid at the operating temperature of the device, and is retained in the cells of the wall members by the electrolyte-permeable member. 7 figures.

32697 Lead base cadmium—tin alloy useful for forming battery components. Rao, P.; Mao, G.W. (to Gould Inc.). US Patent 4,007,056. 8 Feb 1977. Filed date 23 May 1975. 6p.

A cadmium—tin—lead alloy composition containing at least 0.4 percent by weight of both cadmium and tin is used for forming the straps employed which weld together the lugs of the grids in lead—acid storage batteries. The relatively small amount of cadmium and tin provide a large volume fraction of a cadmium—tin eutectic phase that is low melting and serves to facilitate the welding. This alloy composition may also be used to form intercell connectors and terminal posts for such batteries. 3 figures, 1 table.

32698 Plastic case for flat rechargeable cell. Sorensen, D.D.; Erickson, R.A.; Iepson, H.E. (to Gould Inc.). US Patent 4,007,060. 8 Feb 1977. Filed date 30 May 1975. 4p.

A flat, sealed case for a secondary cell includes a flat shallow plastic base and a thin, flat plastic cover. The periphery of the cover is sealed to the base. The case includes at least one internal restraint to prevent bulging of the flat cover and base upon a build-up of internal pressure within the cell case, for example, during recharging. 6 figures.

APPLICATIONS

REFER ALSO TO CITATION(S) 32785, 32786

ENERGY MANAGEMENT AND POLICY

32699 (FEA/T—77/033) Federal energy information gathering activities. A report to the President of the United States and the Energy Resources Council. Zarb, F.G. (Federal Energy Administration, Washington, D.C. (USA)). Dec 1976. 45p. Federal Energy Administration, Washington, DC.

This report on Federal energy-data-gathering activities is provided to fulfill the requirements contained in Section 56(c) of the Federal Energy Administration (FEA) Act of 1974, as amended by the Energy Conservation and Production Act (ECPA). The report presents the FEA activities concerning energy information, both past and planned, since enactment of the ECPA; describes the present system of Federal energy-data-gathering activities; and provides recommendations with respect to the coordination of energy-information activities within the Federal Government.

32700 (IES-A—2) Second annual report for the academic year 1974—75. Reynolds, W.C. (Stanford Univ., Calif. (USA). Inst. for Energy Studies). Dec 1975. 44p. IES, Stanford Univ., CA.

The Institute for Energy Studies is designed to stimulate, facilitate, and promote the development of research and academic programs in energy within existing Schools in the University. The main areas of activity of the Institute are: Energy Information Center; Seminar Program; Interdisciplinary Student-Faculty Studies; Research Initiation; Workshops; Analysis for Public Action; Visiting Professor Program; and Fellowship Program. A major emphasis was placed in 1974-1975 on bringing more of Stanford's great strengths in the policy area to bear on energy problems. A Stanford energy modeling program (PILOT) and a Stanford Western Energy Policy Study (SWEPS) have been initiated. (MCW)

SYSTEMS STUDIES AND TOTAL ENERGY

REFER ALSO TO CITATION(S) 32736, 33575

32701 Use of waste heat at self-supply with power on natural gas basis with total-energy-plants. I. Design and operation of total energy plants and general economic considerations. Auras, H.; Boerstinghaus, H.; Fox, U. *Heizung-Lueftung-Haustech.;* **26**: No. 1, 19-23(1975). (In German).

The general technical and economic aspects of total energy systems are presented on the basis of examples from the Netherlands. The increasing price of electricity from mains has led to new concepts of energy supply for large consumers, such as office buildings, hospitals, and apartment houses. The natural gas-operated total energy plant used for such purposes is designed to supply all electricity needed for internal consumption by means of low-speed gas engines. The thermal energy needs of the same consumption unit are covered by partial recovery of the waste heat in the hot cooling water and lubricant oil by means of heat exchangers integrated within the total energy plant, and by means of absorption coolers for air conditioning purposes. The extensive use of total energy systems for large consumers, including greenhouses, could result in a reduction of the total natural energy need of the Netherlands by 6 percent. It would also be possible to use sewer gas generated in biological wastewater purification plants.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 32720, 32723, 32728

32702 (INIS-mf—3252) Articles and contributions to the nuclear controversy. I. Wethe, P.I. (ed.). (Institutt for Atomenergi, Kjeller (Norway)). Aug 1976. 143p. (In Norwegian). TIC.

A collection of articles and press items written by staff of Institutt for Atomenergi in the period autumn 1973 - spring 1976.

In the beginning of the 1970s the public interest in nuclear power in Norway was negligible, and an active information campaign might have been interpreted as an attack on the dominant hydroelectric development policy. In 1973 the electricity authorities themselves began to propose concrete nuclear power projects. Over a very short interval of time organised protest groups emerged whose main objective was to hinder the establishment of nuclear power in their own districts. T hese have since developed into agressive national groups and in the period up to the spring of 1975 an intense press debate took place. The staff of Institutt for Atomenergi took an active part in this debate and this collection of articles and contributions gives an impression of the nuclear controversy in Norway from 1973 to 1976.

32703 (INIS-mf—3253) Articles and contributions to the nuclear controversy. II. Wethe, P.I. (ed.). (Institutt for Atomenergi, Kjeller (Norway)). Aug 1976. 85p. (In Norwegian). NTIS (US Sales Only).

A collection of articles and press items written by staff of Institutt for Atomenergi in the period autumn 1975 - spring 1976.

The material in Part 2 of this collection of articles and contributions is a continuation of that in Part 1.

32704 (PB—259 438) Analysis of financing problems in coal and oil shale boom towns. Final report. Gilmore, J.S.; Moore, K.D.; Hammond, D.; Coddington, D. (Denver Research Inst., Colo. (USA)). Jul 1976. Contract FEA-CO-05-50197-00. 238p. Q 11/MF/A01.

The report is a case study of impacts resulting from energy development in four communities. For each community the adequacy of facilities, the tax revenues, and capital needs for facility construction are examined. A variety of financing options are evaluated for their effectiveness based on eight criteria. (GRA)

32705 Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976). 238p.

A rapid increase in oil prices in 1973 caused worldwide economic disruptions and speculations over the long-term international effects of actions by the Organization of Petroleum Exporting Countries (OPEC). Nine economists interpret the implications of higher oil prices in the historical context of international trade and monetary policies as they relate to changes in energy demand and supply. The changing relationships of consumer and producer nations, both for oil and non-oil products, is explored. Capital requirements for new energy source development and investment opportunities for "petrodollars" will initiate new economic and energy policies for all nations, each of which must understand the interdependencies of economic and energy decisions. A separate abstract was prepared for each of the nine chapters. 45 references. (DCK)

32706 Framework for analysing the implications of the rise in oil prices. Corden, W.M. pp 12-24 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Short-term implications of oil price increases are studied in order to develop a framework for cost-benefit analysis. Conclusions are that equilibrium real expenditure will fall as efforts to hold down inflation from resource loss lead to unemployment and reduced output. If the Organization of Petroleum Exporting Countries (OPEC) spend their surplus, the consequences of the transfer effect will be to increase inflation and unemployment and will alter balance of payment deficits in proportion to the relative size of an oil-importing country's transfer. Other effects will be felt as a result of changes in foreign exchange and costs of rationing. Decisions affecting liquidity will depend on whether OPEC keep their surplus in gold and whether oil-importing countries choose to use Special Drawing Rights (SDRs) on the International Monetary Fund. (DCK)

32707 Economic issues for the oil-importing countries. Corden, W.M.; Oppenheimer, P. pp 25-38 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Balance of payment deficits resulting from oil price increases will affect future United Kingdom economic policy decisions, specifically those involving loans for consumption as opposed to loans for investment. The demand reduction effects of higher prices are offset to some extent by the Organization of Petroleum Exporting Countries's (OPEC) surpluses, part of which will be spent to increase exports of non-OPEC and part as capital investment. The net

result should keep demand constant if the tendency to put some of the OPEC surplus into savings is offset by extra investment from other sources. Governments may need to borrow and spend some of OPEC's savings in order to keep the money in circulation and generate the funds needed for alternate energy development. If the British government does not borrow, demand for foreign goods will shift to domestic products and further depreciate the current account. Although the size of OPEC funds available for international investment introduces a number of problems, the basic issues revolve around whether the borrowing country uses the funds for a deficit budget to maintain consumption or for a fast return on investment that promotes North Sea and other oil production opportunities. (DCK)

32708 Oil payments and oil debt and the problem of adjustment. Tumlir, J. pp 39-64 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Highly industrialized countries, which have benefited from cheap imported oil in the past, should now reduce their oil consumption by investing in alternative energy sources. One way to accomplish this is for the developed countries to open their markets to the developing countries and assist with the transfer of low-technology industries. A real transfer of goods and services, as opposed to a financial (or paper) transfer, can enable the oil-producing countries to invest their oil surpluses on real assets at home. Other options include holding the surplus and buying assets abroad. The case for each of these options is developed and analyzed for its national and worldwide social, economic, and political implications. Industrial nations have a responsibility to provide a structure for productive assets and technology as well as a reserve of natural resources for future generations. 19 references. (DCK)

32709 Trade prospects for developing countries after the rise in oil prices. MacBean, A. pp 65-93 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Trade prospects for developing countries are analyzed on the basis of each country's principal exports and the extent of its dependence on imports of food, fertilizers, and oil. Export values and percentage share of exports are compared for developing and developed countries, with the note that the developed countries continue to export more non-oil commodities than the developing countries which depend on their own exports for survival. Third World countries are grouped according to their status as exporting and importing nations rather than a general grouping of developing countries. The effects of inflation, exchange-rate fluctuations, actions of the Organization of Petroleum Exporting Countries (OPEC), and increases in the price of mineral and agricultural raw materials all contributed to raise the prices of basic commodities. Oil-importing countries have had to increase their exports in order to meet the costs of higher imported oil prices. Indirect effects of the oil price increase have been to slow world economic growth and threaten worldwide recession and shortages of raw materials for food and manufactured goods. Commodities, lacking the broad demands for oil, are not likely to allow cartels to form that have the impact of OPEC. 18 references. (DCK)

32710 Impact of the oil crisis on the energy situation in Western Europe. Ray, G.F. pp 94-130 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Inexpensive and convenient petroleum products dominated energy supplies of western Europe to such an extent in the last decade that the 1973 oil crisis caused serious economic disruptions. Statistics detail the energy requirements and consumption for each of the 17 nations. Tables showing each country's dependence on crude oil imports indicate that in 1970 western Europe as a whole imported 97 percent of the crude oil it consumed, 14 percent of the coal, and 3 percent of the natural gas, with a 40 percent total energy import. Some countries were able to produce some hydroelectric and nuclear power. The preference for petroleum had caused a decrease in coal production, which had both economic and social implications for those countries whose social traditions were organized around the coal industry. Non-coal-producing countries had been eager to develop a petroleum refining capacity. Policies for the countries were therefore divergent (in spite of a recognized need for unification) and resulted in a larger number of major suppliers of materials and goods than the total western Europe market warrants. The long-range outlook is promising if commercially successful technology can relieve oil dependence. In the short-term, policies to promote conservation, efficiency, and increased energy supplies will require a general integration of the economy. 23 references. (DCK)

32711 Capital requirements for developing alternative sources of energy. Rybczynski, T.M. pp 131-150 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

New energy policies are evolving in western Europe to form the capital needed for developing alternative sources of energy. The high prices of petroleum have had such world-wide economic impact that new policies are forming to reduce energy demand, increase energy independence, and hold down imported oil prices. The implications of these policies are analyzed for the major industrial users: the United States, United Kingdom, European Community, and Japan in terms of each user's current and future energy position. Large amounts of money will be invested in obtaining the goals of energy self-sufficiency and will require other types of spending to be restricted, probably with high interest rates and high prices. The United States and United Kingdom are not expected to be as adversely affected as the other oil-importing countries, and this will influence the relationships of foreign trade, investment, and monetary systems. Much of the money for investment will come from domestic and foreign savings, including "petrodollars" from the oil-exporting countries. (DCK)

32712 Higher oil prices and the international monetary system. Johnson, H.G. pp 151-170 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

The new wealth of the Organization of Petroleum Exporting Countries is putting pressure on the oil-importing countries to increase their exports, especially military equipment, and this is increasing distrust and security concerns. A trend developed prior to the 1973 oil crisis toward integrating goods, capital, and labor into a world market (as evidenced by direct investment and liquid capital) so that a fixed-exchange rate system caused individual countries to experience the same monetary trend as the general trend. The American decision to finance the Vietnam War by monetary expansion instead of taxation changed this relationship. A floating-rate system returned to national policymakers a control over domestic currency and inflation and introduced political complications in the form of (1) redistribution of income as food and oil prices increased, (2) the need to break inflationary expectations, (3) the difficulty of maintaining public attention, and (4) the difficulty of having the public perceive government actions as credible. A return to a fixed-rate system being unlikely, a country can still choose between cutting consumption and borrowing against future production and consumption. (DCK)

32713 Higher oil prices and the reform of the international trading system. Ray, G.F. pp 171-179 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

Structural changes in the international trading system as a result of oil price increases centered in the Organization for Economic Cooperation and Development (OECD) and the General Agreement on Tariffs and Trade (GATT). Structural changes were needed to meet the new demand for oil substitutes and less-energy-intensive products and services. Contraction and unemployment in some areas are offset by expansion and new jobs in others. Monetary transfer and the recycling of "petrodollars" exposed weaknesses in the GATT regulatory system that fail to prevent economic measures in one country from causing serious disruptions in another country. Relations between consumer and producer nations can become strained if individual countries allow internal pressures to force bilateral trade agreements without considering the economic impact on other nations. 8 references. (DCK)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 33199

32714 (UCRL—13710(Pt.1)) **Energy, the environment, and land use: literature review. Final report.** (Donovan, Hamester and Rattien, Inc., Washington, D.C. (USA)). 5 Nov 1976. Contract W-7405-ENG-48;PO-4416803. 190p. Dep. NTIS $7.50.

The objective of the literature review of 150 publications was to collect, categorize, and review issues addressing the interface of energy, environment, and land use. Papers are reviewed on energy supply, energy demand, energy and transportation, and energy and agricultural production. A number of review methodologies are involved. (MCW)

32715 (UCRL—13710(Pt.2)) **Energy, the environment, and land use. Final report.** (Donovan, Hamester and Rattien, Inc., Washington, D.C. (USA)). 5 Nov 1976. Contract W-7405-ENG-48;PO-4416803. 151p. Dep. NTIS $6.75.

The purpose of this effort is to explore the critical energy issues that interface with land as a subset of the total environment. This is true for both energy supply and energy demand activities. In general, the energy, environment, land use interface for any area can be fully understood only within the social, economic, political, and legislative framework of the entire issue. Two distinct concepts relate energy, land use, and the environment. They emerge as a direct result of two disparate views of land use, and result from the fact that energy supply functions have very different impacts on the

environment than do energy demand functions. One concept concentrates centrally on the environmental impact of energy supply. Energy supply activities comprise the chain of events which bring energy resources from the ground, process them and distribute them to the consumer. The second concept concentrates on the way in which land use patterns determine consumption of energy and affect the environment. The configuration of land use activities, such as housing density, transportation corridors, relative distance to work, and facility siting exercises a key influence over the way energy is consumed. Altering the pattern of land development may result in large variations on the demand for energy.

32716 (UCRL—13710(Pt.3)) **Energy, the environment, and land use: legislative review. Final report.** (Donovan, Hamester and Rattien, Inc., Washington, D.C. (USA)). 5 Nov 1976. Contract W-7405-ENG-48;PO-4416803. 90p. Dep. NTIS $5.00.

This report is a first attempt at pulling together both pending and existing legislation that touch on environmental, land use, and energy concerns. Regulations are discussed only as they interpret the legislation. Included in the review is a brief insight into state energy-facility siting requirements. This is done by looking at a state with "one stop" siting (Maryland) vs. a state with a less-coordinated approach (Texas). The legislative review is divided into two parts; (1) legislation and regulations affecting energy supply; and (2) legislation and regulations affecting energy conservation. An appendix contains a listing of relevant Federal laws, both existing and proposed. The appendix follows the progression of the energy fuel cycle from energy harvesting, through processing, transportation, production, transmission, and storage and disposal. (MCW)

32717 **Does water use restrict the location of industrial air polluters.** Santini, D. (Argonne National Lab., IL). *Water, Air, Soil Pollut.;* 5: No. 2, 185-194(Dec 1975).

Water use in industrial production as a cause of geographical clustering of major air-polluting industries is examined. It is shown that the majority of particulate and sulfur oxide emissions in the State of Illinois is emitted by industries using more than five billion liters of water per establishment per year, and that the majority of industrial air pollutants is emitted within urban areas which are on water bodies with high and consistent volumes of water available. These and other results cited in the paper imply that any policy directly or indirectly promoting geographic dispersal as a means of reducing air pollution concentrations and population exposure rates is likely to be limited in effectiveness. It is suggested that such a policy can be effective only if at least one of two specified conditions is met. However, these conditions do not, by themselves ensure the success of such a policy. Finally, it is observed that the conjunction of air pollution with industrial water use indicates that much closer attention is needed to the relationship between air pollution and water pollution policies.

32718 **Environment and conservation in energy research and development.** Washington, DC; Council on Environmental Quality (1976). 135p. GPO $2.00.

The Energy Research and Development Administration was established in 1975 with a nonnuclear energy RD and D mandate to complement existing nuclear programs. In the implementing legislation, the Nonnuclear Energy Research and Development Act of 1974, the Congress paid particular attention to two areas that had been largely neglected in nonnuclear energy technology development: environmental protection and energy conservation. The act gave the Council on Environmental Quality unique responsibilities with respect to Federal nonnuclear energy RD and D programs: to conduct an ongoing analysis of the adequacy of attention to energy conservation methods and environmental protection and to report to the President, the Congress, and the Administrator of ERDA on Council findings. This report is the first under that mandate; it covers activity through March 1976. The principal focus here is the Energy Research and Development Administration; also examined are related programs of the Environmental Protection Agency. In addition to overall assessment of planning and implementation, two areas were analyzed in depth in order to determine the extent to which environmental and conservation considerations are built into ERDA programs, namely: coal technology and end use conservation.

32719 **ERDA authorization, Fiscal Year 1977. Part V. Environment and safety. Hearing before the Subcommitee on Energy Research, Development and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fourth Congress, Second Session, February 28, 1976.** Washington, DC; Committee on Science and Technology (1976). 288p. GPO.

The first year of ERDA's operation is reviewed for budget authorization. Budget requests are based on near- and mid-term technology while providing some concurrent support to mid- and long-term technologies. Eighty-five percent of the budget request is for fossil energy (87 percent coal; 9 percent oil and gas; 4 percent oil shale) with the remaining 15 percent for nuclear support. Primary nuclear funding is related to uranium mill tailing corrective action and development of an aerial radiological monitoring system to measure pollution discharges and dispersion patterns over a large area. A first report from the Council on Environmental Quality is included with heavy emphasis on conservation efforts along with environmental protection. Included also is a reprint of a study on the impact of power plant siting on California's water resources, which follows ERDA's requirement to carry out comprehensive national and site-specific assessments of water availability and of impacts of water demand associated with new energy technologies. (PCS)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 32718, 32741

32720 **Energy issues in the President's budget for Fiscal Year 1977. Hearing before the Task Force on Physical Resources of the Committee on the Budget, House of Representatives, Ninety-Fourth Congress, Second Session, March 5, 1976.** Washington, DC; Committee on the Budget (1976). 55p. GPO.

The task force met, Rep. Jim Wright, presiding, to discuss the energy proposals contained in President Ford's 1977 budget. The presiding officer felt that a need existed to know what was going to be the budget impact of the proposals related to the Energy Independence Authority dealing with synthetic fuels, uranium enrichment, increased funding for energy R and D, and what budgetary impact is expected from tax cuts to electric utilities; also the question needed investigating regarding the extent to which funding is or is not included in the budget for the recently signed Energy Policy and Conservation Act. Eric R. Zausner, FEA, and other FEA staff members discussed the following: strategic petroleum reserves, Naval petroleum reserves, Naval petroleum reserves/strategic petroleum storage, early storage reserve plan, the Energy Independence Authority, and electric utility tax relief proposals. The prepared statement of Mr. Zausner follows. Dr. Robert C. Seamans, ERDA, then chaired a discussion on the proposed ERDA budget, accompanied by his associates. The prepared statement of Dr. Seamans is included and contains budgetary information concerning research and development, conservation, fossil energy, solar energy, geothermal energy, fusion and fission power, nuclear fuel cycle, space technology, uranium enrichment, and national security programs. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 32072, 32106, 32118, 32309, 32310, 32363, 32452, 32456, 32457, 32458, 32459, 32460, 32461, 32462, 32463, 32464, 32465, 32466, 32467, 32468, 32469, 32470, 32471, 32473, 32474, 32475, 32479, 32481, 32482, 32552, 32666, 32738, 32739, 32744

32721 (EUR—5479) **Plutonium production and utilization forecasts in Europe.** Haijtink, B. (Commission of the European Communities, Luxembourg). 1976. 30p. NTIS (US Sales Only) $4.00.

The planned accelerated growth of nuclear energy generation in the near future will lead to a large production of plutonium in the thermal reactors. Therefore, up to 1985, the major part of the available plutonium will be plutonium recovered from spent uranium-metal, particularly in the United Kingdom and in France. Because of the low demand for fuelling the fast breeder reactors within the near future, a surplus of fissile plutonium will be accumulated in Europe. Even if the planned availability of the oxide reprocessing capacity will be delayed with two or three years, a plutonium surplus will still exist in Europe, e.g.; in 1985: 25-20 tons. On longer term, up to 2000, the plutonium production in thermal reactors will be sufficient to meet the estimated demand for fast breeder reactors at their commercial introduction foreseen for the nineties. That means that all the plutonium surplus needs not to be stocked for use in fast breeder reactors later on but could be recycled in thermal reactors. The magnitude of the available fissionable materials give an idea of the importance to promote, on an industrial scale, the plutonium recycling technology.

32722 **Nuclear energy and America's energy needs.** Washington, DC; AFL-CIO Industrial Union Department (1976). 176p. (CONF-760381—). Industrial Union Dept., AFL-CIO, 815 16th St., NW, Washington, DC.

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

Abstracts were prepared for the ten papers presented. Introductory and closing remarks were given by Peter Bommarito, Conference chairman. The issues of nuclear energy focus on economics, the environment, industrial safety, physical security, international policy, and nuclear wastes, he says. (MCW)

32723 Is nuclear energy economically viable. Meyer, W. (Univ.. of Missouri, Columbia). pp 37-54 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Meyer first cites a hearing carried out in the State of Missouri before the Missouri Public Service Commission concerning the siting of two nuclear power plants. The decision was that the plants should be licensed and allowed to operate since "all of the evidence conclusively proved that electricity produced by nuclear units will be cheaper over the life of the plant. In addition and perhaps more important is the abundance of documentary evidence and testimony before the Commission to the effect that mankind and the environment are considerably more adversely affected by coal-fired plants than by nuclear plants." The advancing prices of oil and gas as these supplies dwindle and the resulting impact on all other energy sources are then reviewed. Coal prices advance because: oil and gas are required to transport and handle it; fossil-fuel power plants are requiring expensive pollution control equipment to further advance power costs. The projected demand factors for uranium and its efficient utilization are discussed. Mr. Meyer contends that if the escalation factor in the cost of fuels can be slowed down (by 5 percent) coal will compete more successfully, otherwise coal is not competitive at all. There exists a need for both nuclear and coal, and the question of how jobs are affected by the decision to go nuclear or coal is briefly surveyed. (MCW)

32724 Is nuclear energy safe for workers and the public. I. Cohen, B. (Univ. of Pittsburgh). pp 58-68 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Dr. Cohen first discusses wastes from coal-burning power plants, then those from nuclear power plants. Coal-fired plants produce more wastes, but nuclear wastes are radioactive. Exposure to natural radiation is about 500 times as much as the public will receive from nuclear power plants. Safe handling of wastes from nuclear plants is reviewed, contrasting the handling to the careless way arsenic or chlorine gas is handled. The burying of radioactive wastes and the effects on ground water are followed. Dr. Cohen cites a substitution scenario: uranium is the source of radium, and radium has been causing some thousands of fatalities per year from time immermerial; therefore, uranium is burned completely up, the Earth will be cleansed of much of its radiation since "uranium is in the long-run a much more dangerous thing than the waste which it turns into when it is burned in a nuclear power plant." Lastly, the burden put upon future generations "to watch" the radioactive wastes is analyzed; calculations show that a thousand years' waste accumulation can be buried in a ten-mile square area, requiring one patrol person parttime to watch. Dr. Cohen sees the burden much greater of our consuming all of the minerals and not leaving any for future generations. The only way he sees to right ourselves with the progeny he feels, is to leave them with the technology that will allow them to live in reasonable comfort without all these resources we are consuming. . . We owe future generations a source of cheap and abundant energy: since solar energy is almost impossible to develop as a cheap source, nuclear is the only source. (MCW)

32725 Is nuclear energy safe for workers and the public. II. Rasmussen, N. (Massachusetts Inst. of Tech., Cambridge). pp 70-79 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Dr. Rasmussen first examines the safety and economics records of nuclear power and finds them unassailable. Since these two items could not cause dissension, he observes that dissension evolves from safety of the power plant itself, the issue of diversion to use nuclear materials to make weapons, and from the disposal of wastes. He reviews how radioactivity can be released to cause an accident, and then cites figures comparing accidents each year in the U.S. with those projected for nuclear accidents. To date, not one person has been killed with the operation of a nuclear power plant. Dr. Rasmussen believes that taking advantage of nuclear power far outweighs its risks since "we have seen what unemployment at the level of 9 or 10 percent has done in this country...to go without power that our industrial society needs to provide livelihood for our citizens will almost surely result in something much more dramatic than that." (MCW)

32726 Is nuclear energy safe for workers and the public. III. McKenzie, J.J. Jr. pp 80-107 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Dr. McKenzie says a national energy policy does exist, being based on synthetic fuels from coal and nuclear energy to meet future demands, and based on a complete lack of attention to conservation. In meeting energy demands for the future, he feels the opportunity still exists to create the scenario that will require meaningful jobs in the process, jobs requiring less capital and less energy. On the risks of nuclear energy, Dr. McKenzie discusses the funding, research, and results of the Atomic Energy Commission's safety program. He airs his views on WASH-1400, the study by Professor Norman Rasmussen, dealing with the possibilities of reactor core meltdowns. He thinks a worse problem resulting from nuclear power plants is that of waste disposal and cites AEC's poor record of managing these wastes in Kansas and elsewhere. In concluding, Dr. McKenzie says: (1) nuclear power may not be the best thing in the world, maybe we should look at other alternatives; (2) conservation is most important, and creates jobs at the same time if handled correctly; (3) AFL-C10 should sponsor a study on energy systems investigating its employment potential, net energy, economic factors, and capital requirements; and (4) construction of nuclear and coal plants will create jobs, but building solar plants will create jobs with fewer restraints on the environment. A panel discussion follows this, the third paper, on nuclear safety for workers and the public. (MCW)

32727 Congressman-scientist looks at nuclear energy. McCormack, M. pp 108-128 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Rep. McCormack aired his views on energy in general and nuclear energy's role in the energy mix of the U.S., stating that this is not an academic debate because the nation is in mortal danger. He further states, our national security, the stability of our economic systems, even our political institutions may well depend upon our ability to develop responsible energy policies and implement rational programs to carry them into effect. It is no exaggeration to say that members of organized labor can play a decisive role in initiating and supporting positive action programs and make the difference between success and catastrophe for our nation during the balance of the century. This is true for all union members and all unions, from the officers of the International to the individuals at the local level." Rep. McCormack is known as a nuclear energy advocate, but he also supports solar energy development, geothermal energy, electric cars, ground transportation, conservation, fission programs, and the breeder program. After reviewing the facts that energy demands will increase and the restraints being imposed resulting in long lead times for all energy sources, the author concludes that nuclear energy is needed. He announced that ERDA will soon tell its options and programs for safety disposing of nuclear wastes--that of converting the wastes to a solid glass. A summary of some voting records in Congress on various energy programs was given and Rep. McCormack said that support in Congress on programs that he deemed necessary has been difficult to muster. (MCW)

32728 Nuclear energy and jobs. Goldfinger, N. (AFL-CIO, Washington, DC). pp 135-146 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Goldfinger, Research Director of AFL-CIO, examines the problem of energy in general, nuclear in particular, and the employment relationship. The energy shortages in the U.S. and its dependence on oil are cited. Directly connected with this serious problem relating to energy are jobs, income, and living standards. If energy is not available, industries will be unable to expand to meet the needs of the growing population; and prices of goods will rise. From an evaluation of what experts have said, Mr. Goldfinger concludes that increased coal production and better coal technology cannot meet energy demands; so the sharp increase both in volume and as a percentage of total energy needed in the future will have to come from nuclear power. Development of alternative sources is necessary, he feels, and intense research on these is needed now. The employment impact in the nuclear energy scenario is analyzed according to the trades involved. It is estimated that 1.5 million jobs in the nuclear industry would be open by the year 2000 if nuclear is to provide one-fourth of energy supplies. The employment picture, assuming abandonment of nuclear energy, is then discussed. (MCW)

32729 What are the states doing about nuclear energy. Clayman, J. (AFL-CIO, Washington, DC). pp 148-156 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America?s energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Clayman, IUD Secretary-Treasurer, first discusses the California initiative. Proposition 15 sought to remove the limitation set for a nuclear accident, as specified by the Price-Anderson bill. It also meant, according to Mr. Clayman, that not only future nuclear development would be arrested, but that the established facilities in the State of California would be completely wiped out; he cites the absurdity of the mandates--that of even insuring against the acts of God or social instabilities. He briefly reviews California-type initiative petitions to be on ballots in other states--Maine, Montana, Michigan, North and South Dakota, Oklahoma, Arkansas, Missouri, Nebraska, Ohio, Oregon, Colorado, and Washington. Mr. Clayman believes such a technical decision should be left to the scientists, and the decision on a matter like nuclear energy should certainly not be decided by popular vote. Even on the safety angle, he recalls data that show "there hasn't been a single fatality that has arisen out of radiation." (MCW)

TRANSPORT AND STORAGE

32730 Energy storage and transport. Bruederlin, H. (Technische Werke der Stadt Stuttgart A.G. (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **21**: No. 11, 541-547(Nov 1976). (In German).

From Reactor meeting; Duesseldorf, Germany, F.R. (30 Mar 1976).

7 figs.; 9 refs.

The report examines future possibilities under the aspect of a production capability not only for electricity, but also for district heat and for liquid and gaseous fuels. Since a large part of the present and future energy requirements in industry and households will be for heat, the transport and storage of energy other than electricity are aspects of growing importance in the future. The author compares and evaluates the different transport and storage systems which are very much influenced by distances and capacities, as is outlined on the basis of a number of economic assessments. Storage facilities are dealt with in terms of short- and long-term storage possibilities for gases and liquids for the generation of electricity and thermal energy. In addition to the classic energy storage systems, a number of new storage principles are under planning, under examination with respect to their economics, or even under construction in some cases.

CONSERVATION

REFER ALSO TO CITATION(S) 32718, 32719, 32769, 32773, 32774

32731 Current activity in appliance design. Kirk, W.B. (American Gas Association Labs., Cleveland). pp 5p., Session VII, Paper 1 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

Factors affecting the design of more efficient appliances are presented, followed by a brief synopsis of recent and new projects aimed at conserving energy. Examples of concepts for achieving higher efficiencies are reviewed.

32732 Energy conservation in the International Energy Agency. 1976 review. Washington, DC; OECD Publications Center (1976). 55p. $6.00.

The International Energy Agency conducted a review of energy conservation in its member countries sector-by-sector and country-by-country. This report concentrates on conservation policies and programs. Results based on the 1976 assessment conclude that: (1) accomplishments and progress by IEA nations have been substantial; (2) a potential still exists for reducing future energy demand in almost every country; and (3) prospects for a continued aggressive conservation thrust in many IEA nations are uncertain. It is shown that actual 1975 consumption was 4.8 percent below actual 1973 data. Even with the slowdown that caused industry to operate substantially below the efficiencies of full capacity, most countries made reductions in the amount of energy consumed for each unit of GDP produced. (MCW)

32733 Energy Extension Service Act of 1975. Hearings before the Subcommittee on Energy Research, Development and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fourth Congress, Second Session on H.R. 11091, March 23, 25, 30; April 1, 1976. Washington, DC; Committee on Science and Technology (1976). 1069p. GPO.

Rep. Ray Thornton, who chaired the series of hearings on this subject, points out the potential benefits of a strong outreach program to encourage the wise and careful use of energy resources. He cites an ERDA study that identified 41.9 percent of the Nation's energy consumption as being in sectors that could be reached by an energy extension service (EES); the study identified such sectors as industrial and commercial establishments, State and local governments, other small establishments such as hospitals, schools, and churches, and rental and owner-occupied residences. Also, it was established that existing national, local, and university programs for reaching these sectors were not effective—thus the real purpose of the subject hearings. Mr. Thornton quoted $30 to $40 million annually as the probable cost of implementing an EES, but then proceeds to show the far greater potential benefits from such a venture. There are statements from 22 Federal, State, city, institutional, and university officials. Appendix I is the memorandum of understanding between FEA and ERDA, April 30, 1976. Appendix II is FEA's State energy conservation plan and feasibility guidelines, Federal Register, June 16, 1976. Appendix III contains five items of "additional material for the record", including the FEA Project Conserve questionnaire. Appendix IV contains 33 "additional statements for the record", mostly governors or state energy officials. It might be noted that Frank Zarb and Roger Sant, Administrator and Deputy Administrator, resp., of FEA, opposed the EES, feeling it would duplicate programs already in effect or planned at FEA. (LMT)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 32722, 32741, 32746

32734 (EPRI-EA—235(Vol.1)) Residential demand for energy. Volume I. Final report. Taylor, L.D.; Blattenberger, G.R.; Verleger, P.K. Jr. (Data Resources, Inc., Lexington, Mass. (USA)). Jan 1977. 148p. Dep. NTIS $6.00.

This study focuses on the residential demand for energy over the period 1956 to 1972, with principal emphasis on the residential demand for electricity; primarily, it deals with decreasing block pricing in the sale of electricity in a manner that is appropriate theoretically and sound econometrically. To this end, a completely new price data set was constructed that is derived from actual residential rate schedules published in the National Electric Rate Book. The price of electricity is represented in the econometric demand functions as the marginal price plus a measure of intramarginal expediture. The basic unit of observation is the state, and the models are estimated using the variance-components technique pioneered by Balestra and Nerlove. Two types of dynamic models are estimated, logarithmic flow-adjustment models in which appliance stocks do not appear explicitly, and stock-adjustment models in which they do. The latter models employ annual estimates for the years 1960 to 1972 of 11 types of electrical appliances that were constructed by Data Resources, Inc., specifically for the project. Results of the study indicate that: (1) the amount of electricity used in homes is important; (2) approaching the demand of electricity (and natural gas) in a two-part tariff framework would seem firmly to be established; and (3) the long-run price elasticity for residential demand may not be as large as previous studies have indicated.

32735 (EPRI-EA—235(Vol.2)) Residential demand for energy: estimates of residential stocks of energy using capital. Volume II. Final report. Verleger, P.K. Jr.; Iascone, F. (Data Resources, Inc., Lexington, Mass. (USA)). Jan 1977. 163p. Dep. NTIS $6.75.

A program of research into the demand for residential energy requires the construction of an adequate data base on the stock of energy using capital. This report details the procedures used to assemble such a data base. The development of data on housing stocks was the most important element of this analysis. Bureau of the Census figures were available for 1960 and 1970. Two methods were used to obtain annual estimates of the stock: (1) data on housing permits authorized were used as investment and a constant rate of depreciation was assumed; and (2) an adjusted annual change in the number of residential electric customers was used as a proxy for investment and depreciation. These methods yielded substantially similar results. Stocks of appliances were estimated by benchmarking annual state saturation rates obtained from Merchandising Week to decennial saturation rates obtained from the Census and multiplying these saturation rates by the stock of houses. This study was hampered by a lack of information on the number of appliances held by consumers, and on the age distribution, size distribution, and historical utilization rates of these appliances. Fortunately, enough data were collected to allow for the construction of a reasonable data set on appliance stocks. However, adequate data could not be gathered to construct estimates of the age, size, or usage types of capital. To

correct this deficiency, it would be necessary for some agency to undertake the development of periodic systematic censuses of consumer holdings of capital.

32736 (KFK-EXT—2/76-1) **Systems analysis and energy policy in Baden-Wuerttemberg.** Boese, P.; Brand, P.; Friede, G.; Gschwendtner, H.; Hanke, H.; Hoecker, K.H.; Hudetz, W.; Klaiss, H.; Legler, H.; Ott, A.E.; Schreiber, G.; Ziesing, H.J. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Angewandte Systemanalyse). Feb 1976. 172p. (In German). (CONF-760245—). Dep. NTIS $6.75.

From Symposium on systems analysis and energy policy; Baden-Wurttemberg Stuttgart, German, Federal Republic of (F.R. Germany) (11 Feb 1976).

Six reports on the state-of-the-art and results of work in the field of regional energy forecasting methods based on a systems analysis approach are presented. The reports deal primarily with the following broad topics: the relation between energy supply and economic development; the impact of a further enlargement of energy conversion plants on the ecological and socio-economic development of the region of Baden-Wuerttemberg with special regard to the location of big energy plants; and the general problems of an application of regionalized, dynamic energy models, and the applicability of models disaggregated by sectors to a specific region.

32737 **Historical background to the world energy crisis.** Rybczynski, T.M.; Ray, G.F. pp 1-11 of In Economics of the oil crisis. Rybczynski, T.M. (ed.). New York; Holmes and Meier Publishers, Inc. (1976).

A supply and demand imbalance for oil in the 1980s was predicted in the late 1960s and became more pressing as American demand increased in the 1970s. Political changes following the 1973 Yom Kippur war resulted in the Organization of Petroleum Exporting Countries (OPEC) raising prices, lowering production, and boycotting nations friendly to Israel. A review of subsequent events covers oil pricing strategies, economic implications of shortages, and reactions of other countries. Causes of the ensuing crisis are attributed to the desire of oil-producing countries to control the extraction and disposition of their major resource and shifts in the supply and demand balance as U.S. and Japan demands for imported oil increased, which improved OPEC's bargaining position. Estimates of surplus income for OPEC are tabulated along with the probable share contributed by the countries of western Europe. 7 references. (DCK)

32738 **Trade unionist looks at energy problems.** Abel, I.W. pp 10-16 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Abel suggests American society use a technique applied in labor-management relations to attack the energy problem--that of finding facts. He indicates that when the leadership of the trade unions has the facts and has gained some perspective, it will be better able to help with the energy problem. He says that the labor movement had not been thinking about the energy problem, but they, like almost everyone else, assumed cheap and abundant energy was unlimited. The labor movement is not committed to a scenario of "no growth," and the experience and inclinations of labor support a belief that the production of nuclear energy is basically safe--in a basically unsafe world. Answers to five questions were hoped to be gained from the conference; is nuclear energy reasonably safe; is nuclear energy a viable source of energy supply in the short run and in the long run; what is the relationship between the future production of greater supplies of nuclear energy and the economic goals of prosperity and full employment; what needs to be done, in the Congress, in the executive branch of government, and in the states and cities, to assure a plentiful supply of energy for homes, commerce, and industry; and how to strike a happy balance between the real need to protect the environment and the economic system. (MCW)

32739 **Inventory of energy sources: none can be overlooked.** Radin, A. (American Public Power Association, Washington, DC). pp 18-35 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Radin feels that energy in the form of electricity is the key to the broad concern about availability and price of energy. He summarizes four areas of concern confronting the U.S. in the power field--the amount of electricity needed, the sources, its cost, and who will pay for it. He believes that the basic aim "should be to supply that amount of electricity needed to maintain and enhance the standard of living for all citizens," and further observes that, to do this, "price increases are inequitable." Mr. Radin believes that, with the abundance of coal in the U.S., a switch back to coal must be made. The importance of the breeder in the future is reviewed. It is pointed out that if 10 percent of the 70 million homes in the U.S. were converted to solar energy for heating and cooling by 1990, only slightly more than one percent of our national energy demand would be met. MHD, fuel cells, or fusion will employ fuels in a more efficient manner, but scientific, engineering, and economic barriers must be hurdled before these devices can be effectively utilized. The safety of nuclear power is briefly discussed, then Great Britain's experience with nuclear power is reviewed. It is observed that whatever decisions are made concerning future production of energy, the costs of these choices will be paid by consumers. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 32452, 32705, 32711, 32712, 32713, 32716, 32717, 32719, 32729, 32733, 32736, 32746, 32769, 32773, 32774

32740 (KFK-EXT—2/76-1) **Systems analysis and energy policy in Baden-Wuerttemberg.** Boese, P.; Brand, P.; Friede, G.; Gschwendtner, H.; Hanke, H.; Hoecker, K.H.; Hudetz, W.; Klaiss, H.; Legler, H.; Ott, A.E. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Angewandte Systemanalyse). Feb 1976. 163p. (In German). (AED-Conf—76-393-000). TIC.

From Symposium on systems analysis and energy policy in Baden-Wuerttemberg; Stuttgart, F.R. Germany (11 Feb 1976).

With figs. and tabs.

In this volume six reports on the state-of-the-art and results of work in the field of regional energy forecasting methods based on a systems analysis approach are presented. The reports deal primarily with the following broad topics: the relation between energy supply and economic development; the impact of a further enlargement of energy conversion plants on the ecological and socio-economic development of the region of Baden-Wuerttemberg with special regard to the location of big energy plants; the general problems of an application of regionalized, dynamic energy models and the applicability of models disaggregated by sectors to a specific region.

32741 **Research and development in energy policy.** Ruttenberg, S. pp 161-172 of In Nuclear energy and America's energy needs. Washington, DC; AFL-CIO Industrial Union Department (1976).

From Conference on nuclear energy and America's energy needs; Washington, District of Columbia, United States of America (USA) (18 Mar 1976).

See CONF-760381—.

Mr. Ruttenburg (of Ruttenburg, Friedman, Kilgallon, Gutchess, and Associates) states that it is not worthwhile to say that a specified energy source is the answer to the U.S. energy problem--unless research and development is close behind. The facts are that the U.S. is depending more and more on imported oil; that U.S. production of crude oil reached its peak in 1972 and continues to decline; and that natural gas production in the U.S. has declined in recent years. Mr. Ruttenburg feels that we must have increased efficiency of production of energy, must improve safety, and must protect the environment--in all cases, considering near-, mid-, and long-term goals. He criticizes the ERDA policy in R and D of "providing overall leadership and undertaking only those efforts industry cannot" as, in effect, abandoning a sound and solid program; it involves, he feels, placing far too much reliance on the private initiative. To rely upon the private sector to develop R and D will be fruitless and frustrating, in his judgment; private efforts must be directed at a plan and at the objectives and not at private enhancement. A Manhattan-Project or World War II synthetic-rubber type approach is needed. Mr. Ruttenburg feels; in any case, the Government must decide what the priorities are, then proceed to see that they are carried out; it cannot be the reverse, where private industry sets the priorities or the basis of what will be profitable. (MCW)

32742 **Horizontal integration of the energy industry. Hearings before the Subcommittee on Energy of the Joint Economic Committee, Congress of the United States, Ninety-Fourth Congress, First Session, November 19 and December 8, 1975.** Washington, DC; Joint Economic Committee (1976). 224p. GPO.

Two days of hearings were held to address the issue of how domestic energy resources should be controlled and, specifically, the recent development of oil companies buying major shares in coal, uranium, geothermal, and other energy industries. Senator Edward Kennedy, committee chairman, expressed concern that horizontal integration could serve to eliminate competition between both companies and resources and could give enormous economic and political power to the oil industry. Witnesses included Mayor Alioto of San Francisco and representatives of the oil companies, the Federal Trade Commission, and economists. Speaking for the U.S. Confer-

ence of Mayors, Alioto cited the Department of Justice for not dealing with the problem of interlocking controls, and looks to legislative processes to ensure a free competitive market for energy resources. Economist John Wilson expressed concern that other resources may follow the same route of bad regulatory policies and monopolized control as the petroleum industry. Oil executive C. Howard Hardesty, Jr. pointed out that with domestic energy needs so broad, the nation should welcome those willing and able to contribute. He also stated that horizontal integration stimulates competition within each energy industry. Speakers submitted data on consumption, production, prices, income, and affiliate acquisitions of energy industries. (DCK)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 32704

COAL

REFER ALSO TO CITATION(S) 31771, 32726, 32747

PETROLEUM

REFER ALSO TO CITATION(S) 31813, 31856, 32705, 32706, 32707, 32708, 32709, 32710, 32711, 32712, 32737, 32742

32743 (FEA/H—77/004) **Determination of equitable pricing levels for North Slope Alaskan crude oil.** (Mortada International, Dallas, Tex. (USA)). Nov 1976. vp. Federal Energy Administration, Washington, DC.

Three field development plans were analyzed. Case I: Only Prudhoe Oil Pool (consisting of Sadlerochit, Sag River, and Shublik formations) is developed. Field is put on production in mid-1977. Production rate reaches 1.5 MMB/D by early 1979 and is held at that rate until mid-1986, and then declines. Gas sales begin in 1983 at 2 BCF/D. TAPS' capacity expands to 1.5 MMB/D. Case II: Field development plans include lower reserve estimates of Kuparuk and Lisburne Oil Pools. TAPS' capacity expands to next level of 2 MMB/D. Prudhoe Oil Pool is produced at 1.6 MMB/D. Contributions of Kuparuk and Lisburne Oil Pools bring production rate to 1.77 MMB/D. Production rate peaks in 1986 and then declines. Case III: Field development plans include upper reserve estimates of Kuparuk and Lisburne Oil Pools. TAPS' capacity and Prudhoe Oil Pool production rate are unchanged from Case II. Contribution of Kuparuk and Lisburne Oil Pools brings rate of production to 1.915 MMB/D. Production rate peaks in 1986 and then declines.

32744 (UCRL—52180) **Oil, gas, uranium, and thorium: supply and depletion, with special reference to California.** Borg, I.Y.; Stone, R.; Puchlik, K.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Dec 1976. Contract W-7405-ENG-48;CSERCDC-4-0077. 220p. Dep. NTIS $7.75.

The assessment of global resources of gas, oil, uranium, and thorium with emphasis on California is presented. The forecasting of depletion is presented for the resources from the historical production data, the estimate of future production, and the size of the total resource available. Detailed data are provided under the following chapters: Methodology; Oil Supplies; Oil Depletion Forecasts; Natural Gas Supplies; Natural Gas Depletion Forecasts; Uranium Supplies; Uranium Depletion; Thorium Supply and Depletion; and finally, a chapter on new work, new appraisals of reserves and undiscovered resources, and new studies on pipeline routes that promise to affect national and state planning. (MCW)

NATURAL GAS

REFER ALSO TO CITATION(S) 31888, 31912, 32743, 32744

32745 (PB—260535) **Projected natural gas curtailments and potential needs for additional alternate fuels: 1976—1977 heating season.** Bass, A. (National Energy Information Center, Washington, D.C. (USA)). Nov 1976. 76p. (FEA/B—76/463). NTIS $5.00.

The purpose of this analytical effort was to predict the impact of curtailments of natural gas at the end-user level during the 1976 to 1977 heating season. Impact is reflected not in the amount of curtailments but rather in the availability of alternate fuels or emergency gas volumes which can be substituted for natural gas in the event of a shortage. Data were provided on an actual basis (by month) for the 12-month period April 1, 1975 to March 31, 1976, and projected data were requested for the period April 1, 1976 to March 31, 1977. The monthly data enabled the determination of additional gas curtailments projected for the 1976-1977 heating season (November, 76-March, 77). This report discusses all regions of the United States and presents data on each State and the District of Columbia. All projections and findings in this report related to deliveries, curtailments, and needs for alternate fuels during the 1976-1977 winter are based on assumptions of normal winter weather conditions. These projections of normal winter weather are made by each gas company for the geographical areas where gas service is provided to its end-use customers.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 32734, 32735, 32739

32746 (AD—A032234) **Regulatory rationing of electricity under a supply curtailment.** Acton, J.P.; Mowill, R. (Rand Corp., Santa Monica, Calif. (USA)). Apr 1976. 30p. (P—5624). Q 03/MF/A01.

When the Organization of Arab Oil Producing Countries voted in October 1973 to embargo shipments of oil and oil products and to raise prices in general, all uses of energy came under scrutiny. Electric utilities that rely heavily on fuel oil or natural gas for generation were especially vulnerable to serious disruptions in supplies. A variety of policy measures for affecting demand were considered at that time. These can be divided broadly into (1) measures that would cut consumption by raising prices and (2) measures that would cut consumption by voluntary or mandatory rationing. The merits of these alternative approaches have been debated at length by economists and policymakers. Los Angeles chose to meet its problem with a city ordinance requiring customers to reduce their consumption of electricity relative to the preceding year. The discussion focuses on three questions: (1) what was the Los Angeles plan; (2) what were its immediate and longer run effects on electricity consumption; (3) what does this experiment suggest about the relative desirability of such an approach were another fuel or other crisis to occur. (GRA)

ELECTRIC POWER GENERATION

32747 (FE—2453-1) **Benefit-cost evaluation of the ERDA Fossil Energy Combustion and Advanced Power Development Program.** Bertman, L.; Cox, D.; Lamb, G.; Morris, J.; Pfeffer, J.; Rivas, M. (Mitre Corp., McLean, Va. (USA)). Jul 1976. Contract EX-76-C-01-2453. 183p. Dep. NTIS $7.50.

The objective of this benefit-cost evaluation is to assess the implications of the investment of Federal funds in the ERDA/Fossil Energy Combustion and Advanced Power Development (CAPD) Program. Technologies considered in this study include five "Advanced" systems under development in the CAPD Program and other "Baseline" systems that will be competing in the electric utility market for new base- and intermediate-load generating capacity by the year 2000. Life-cycle busbar costs of electric power for each system are calculated, based upon estimated performance and cost characteristics. Market shares by region and year are estimated for the systems, and the benefits associated with the projected Federal RD and D investment are determined by comparison of nationwide electric power generating costs for alternative scenarios. The scenarios are distinguished by assumptions relative to the technologies considered, the price of coal, the electric energy demand, and the nuclear market share.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 32732, 32764, 32765

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 32747

SOLAR

REFER ALSO TO CITATION(S) 32240, 32244

GEOTHERMAL

32748 **ERDA authorization, Fiscal Year 1977. Part III. Geothermal. Hearing before the Subcommittee on Energy Research, Development and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fourth Congress, Second Session, February 19, 1976.** Washington, DC; Committee on Science and Technology (1976). 123p. GPO.

The hearing focused on the proposed budget and program for the ERDA Geothermal Energy Division and on the adequacy of the proposed activities to implement the legislative mandates of the Geothermal Research, Development, and Demonstration Act of 1974, Public Law 93-410. One objective of the law was to establish a comprehensive program for research, development, demonstration,

and commercial demonstration of this important energy resource. Another primary objective of the 1974 Geothermal Energy Act was to streamline and coordinate the splintered jurisdictions of the Federal agencies involved in geothermal energy. A major activity set forth in the Act is a resource inventory and assessment program. In addition, the Act established an R and D program to underpin a demonstration program and analyzed the institutional barriers to commercialization of geothermal energy. The budgetary provisions and the strategy for managing these programs were examined at the hearing. The legislative history of the act indicates that it was the intent of the committee to have 6 to 10 electrical powerplants of approximately 10 to 40 megawatt capacity on line by the end of fiscal year 1980. Rep. Mike McCormack, presiding chairman of the subcommittee, stated: "In looking at the proposed fiscal year 1977 budget, the subcommittee must express its clear concern that this objective appears to be in jeopardy due to the absence of any specific construction items for geothermal energy demonstration plants. We want to clarify what the differences were between the division request and the Presidential budget submission for demonstration projects." The witnesses heard on these and other geothermal issues were Dr. Robert L. Hirsch, Dr. Eric H. Willis, Dr. Vincent E. McKelvey, and Dr. Richard S. Fiske. (MCW)

OTHER

REFER ALSO TO CITATION(S) 32774

ENERGY CONVERSION

MHD GENERATORS

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 32750

MATERIALS, COMPONENTS, AND AUXILIARIES

32749 **Production of MHD fluid.** Lacey, J.J.; Kurtzrock, R.C.; Bienstock, D. (to Energy Research and Development Administration). US Patent 3,976,592. 24 Aug 1976. Filed date 19 Dec 1974. 8p.
PAT-APPL-534,328.

A hot gaseous fluid of low ash content, suitable for use in open-cycle MHD (magnetohydrodynamic) power generation, is produced by means of a three-stage process comprising (1) partial combustion of a fossil fuel to produce a hot gaseous product comprising CO_2, CO, and H_2O, (2) reformation of the gaseous product from stage (1) by means of a fluidized char bed, whereby CO_2 and H_2O are converted to CO and H_2, and (3) combustion of CO and H_2 from stage (2) to produce a low ash-content fluid (flue gas) comprising CO_2 and H_2O and having a temperature of about 4000° to 5000°F. 2 claims, 1 figure.

DUCT ENGINEERING AND FLUID DYNAMICS

32750 **Nature of fluctuations in an open cycle magnetohydrodynamic generator.** Scott, M.H. Knoxville, TN; University of Tennessee (1976). 170p. University Microfilms Order No. 76-24,850.
Thesis (Ph. D.).

Studies have been carried out in an attempt to elucidate some pertinent characteristics of the fluctuations in a magnetohydrodynamic (MHD) generator. These studies combined both theoretical and experimental work in a unified approach to the problem. Several parameters which were considered to be of importance in the MHD generator were measured over a bandwidth large enough to encompass all significant frequency contributions. The first parameter measured was a signal proportional to the filtered plasma radiation and has significance in its relation to plasma temperature. The other parameters were all differential voltages measured between various electrodes in the generator but were obtained under different conditions. Firstly, the differential voltage was determined across electrodes in a Hall channel designed to measure the conductivity of the plasma with an axially imposed electric field and no applied magnetic field. These measurements were then repeated in the MHD channel in the presence of an applied magnetic field for comparison. Finally, the differential voltage associated with a high frequency signal applied across the ends of the generator was measured. The objective in making this measurement was to ascertain the impact of the coupling mechanism between the plasma and the electrode on fluctuations in voltage. All the measured signals were analyzed within the framework of random process theory so that their respective time and frequency resolved behavior could be ascertained. On the basis of theoretical considerations, three models were advanced to describe the behavior observed experimentally. The relationships between the experimental and theoretical influences are discussed. Although insufficient data exists to completely parameterize the problem in terms of the models presented, a qualitative understanding of the sources and the interactions of the fluctuations in the generator is reached.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 32168, 32169

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

32751 **Thermionic converter.** Rasor, N.S.; Britt, E.J. (to Energy Research and Development Administration). US Patent 3,983,423. 28 Sep 1976. Filed date 9 Jan 1975. 8p.
PAT-APPL-539,746.

A gas-filled thermionic converter is provided with a collector and an emitter having a main emitter region and an auxiliary emitter region in electrical contact with the main emitter region. The main emitter region is so positioned with respect to the collector that a main gap is formed therebetween and the auxiliary emitter region is so positioned with respect to the collector that an auxiliary gap is formed therebetween partially separated from the main gap with access allowed between the gaps to allow ionizable gas in each gap to migrate therebetween. With heat applied to the emitter the work function of the auxiliary emitter region is sufficiently greater than the work function of the collector so that an ignited discharge occurs in the auxiliary gap and the work function of the main emitter region is so related to the work function of the collector that an unignited discharge occurs in the main gap sustained by the ions generated in the auxiliary gap. A current flows through a load coupled across the emitter and collector due to the unignited discharge in the main gap. 7 claims, 5 figures.

FUEL CELLS

DESIGN AND DEVELOPMENT

32752 (AD-A—012292) **POBAL-S, the analysis and design of a high altitude airship. Final report, October 1972—March 1975.** Beemer, J.D.; Parsons, R.R.; Rueter, L.L.; Seuferer, P.A.; Swiden, L.R. (Raven Industries, Inc., Sioux Falls, S.Dak. (USA)). Feb 1975. 184p. (R—0275006). NTIS.

An engineering analysis and development effort has been executed to design a superpressure airship, POBAL-S, capable of station keeping at an altitude of 21 kilometers for a duration of 7 days while supporting a payload weighing 890 Newtons and requiring 500 watts of electrical power. A detailed parametric trade-off between various power sources and other design choices was performed. The computer program used to accomplish this analysis is described and many results are presented. The system concept which resulted was a fuel cell powered, propeller driven airship controlled by an on-board autopilot with basic commands telemetered from a ground control station. Design of the balloon, power train, gimbaled propeller assembly, and electronic/electrical systems is presented. Flight operations for launch and recovery are discussed.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 32755, 32756

32753 **Hydrophilic electrode.** Baker, B.S.; Klein, M.G. (to Energy Research Corp.). US Patent 3,898,099. 5 Aug 1975. Filed date 18 Mar 1974. 5p.

A mixture of powdered poly(tetrafluoroethylene) and active material is formed into the electrode; the poly(tetrafluoroethylene) comprises at most 3% of the mixture. (RWR)

32754 **High temperature fuel cell electrolyte.** Baker, B.S.; Marianowski, G. (to American Gas Association, Inc.). US Patent 4,009,321. 22 Feb 1977. Filed date 20 Dec 1972. 4p.

The specification discloses an improved paste electrolyte composition for use in a high-temperature molten carbonate fuel cell, using substantially pure alkali metal aluminate formed from reactive alumina as the only inert material in the electrolyte. Finely divided reactive alumina substantially completely free of silica is admixed with alkali metal carbonates and fired to remove carbon dioxide to form as final inert carrier material substantially pure inert alkali metal aluminate. The initial composition of the starting mixture is selected so that the final composition is between 40 and 70 percent by weight alkali metal carbonates. In contrast to magnesia supported fuel cells which show a 40 percent drop-off in power output, the aluminate paste electrolyte-utilizing fuel cells of the invention show essentially no deterioration. 1 claim.

APPLICATIONS

REFER ALSO TO CITATION(S) 32752

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

32755 Difference of waterproofed electrodes from hydrophilic ones. Chirkov, Yu.G. (Inst. of Electrochemistry, Moscow). *Elektrokhimiya;* **11**: No. 1, 50-56(1975). (In Russian).

A model of the structure of waterproofed electrodes has not been obvious before now and cannot be established by using traditional methods for studying porous media. Only one method, mathematical modeling, seems to be effective. The case of Ftoroplast and Pt electrodes is discussed in view of the modeling technique.

32756 Difference of waterproofed electrodes from hydrophilic ones. III. Model of cylindrical gas pores. Chirkov, Yu.G. (Inst. of Electrochemistry, Moscow). *Elektrokhimiya;* **11**: No. 1, 43-49(1975). (In Russian).

When the model of the structure of a porous waterproofed electrode is unknown, a model of cylindrical gas pores permits one to calculate the basic characteristics of the electrode. The J. Giner (1969) model is discussed and applications of the model to Ftoroplast and Pt electrodes are given. Comparison with experimental curves shows the possibility of determining the stages which limit the generation of current in the electrode.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 32733

BUILDINGS

REFER ALSO TO CITATION(S) 32732

32757 (BNL—50586) **Energy transport control in window systems.** Berlad, A.L.; Salzano, F.J.; Batey, J. (Brookhaven National Lab., Upton, N.Y. (USA)). 15 Sep 1976. Contract EY-76-C-02-0016. 27p. Dep. NTIS $4.00.

Energy transport in window systems involves conductive, convective and radiative processes. Currently utilized twinpane systems generally inhibit convective transport through the use of small pane separation distances. These distances are normally of the order of 0.5 inch. However, substantial increases in pane separation distances do not necessarily imply supercritical Rayleigh numbers, and correspondingly high convectively-influenced heat loss rates. Large pane separations and subcritical Rayleigh numbers may both be achieved if other convection defeating devices are employed in the interplane regime. This study is concerned with possible new convection defeating apparatuses and techniques for window systems. It is found that selected convection defeating equipment may also be used for effective radiation and conductive control. Heat transfer measurements of initial window designs confirm the utility and promise of the window systems under study.

32758 Heating installation comprising a heat pump and a fuel-fired boiler with a radiator circuit. Gustafsson, B.U. (to Projectus Industriprodukter AB). US Patent 3,986,664. 19 Oct 1976. Priority date 18 Apr 1974, Sweden. 6p.

There is provided a heating installation comprising a heat pump and a fuel-fired boiler to which a radiator circuit is connected. A separate hot water heater may be coupled in parallel with the boiler. The hot side of the heat pump is connected to a first shunt pipe in the radiator circuit and is thus coupled in parallel with the boiler. A second shunt pipe is coupled in parallel with the boiler and a third shunt pipe is connected between the hot side of the first shunt pipe and the second shunt pipe. A first threeway shunt valve is connected between the first and third shunt pipes and a second threeway shunt valve is connected between the second shunt pipe and the hot side of the radiator circuit. These two shunt valves may be interlocked. Further the compressor of the heat pump may be arranged to be controlled by the pressure of the refrigerant in the heat pump circuit between the evaporator and the compressor.

32759 Lamp energy saving spacer. Rowe, L.A. US Patent 3,993,386. 23 Nov 1976. Filed date 2 Sep 1975. 6p.

An adapter for fluorescent lamps is disclosed which permits fluorescent tubes of lower wattage and shorter length to be installed in lamps and light fixtures which normally require fluorescent tubes of greater wattage and longer length.

RESIDENTIAL

REFER ALSO TO CITATION(S) 32731, 32734, 32735

32760 Fireplace. Cesa, V. US Patent 4,006,729. 8 Feb 1977. Priority date 12 Mar 1974, France. 4p.

A wood burning fireplace is described in which exterior air is heated during flow through a chimney hood. Recirculated air from the room is drawn in and mixed with the heated fresh air in a zone formed between the chimney hood and a decorative hood casing. A linked damper arrangement is provided with one damper on the chimney pipe to control the fire draught and one on the fresh air inlet so that the amount of fresh air admitted is proportional to the amount of air extracted from the room.

32761 Room heating apparatus using combustion. Nishi, A.; Futaguchi, S.; Ishida, A.; Ito, T.; Nomaguchi, T.; Makino, T.; Saito, T. (to Mitsubishi Denki Kabushiki Kaisha). US Patent 4,006,728. 8 Feb 1977. Priority date 13 Feb 1971, Japan. 8p.

Room heating apparatus is described having a burner disposed in the upper part of a body to which air for combustion is forcibly supplied from a blower, a heat exchanger and a combustion chamber serially connected below the burner, and a second blower for recycling air from the room over the outer surfaces of the heat exchanger and the combustion chamber being disposed in the bottom of the body. The combustion chamber and the heat exchanger are substantially flat-shaped in configuration being on the order of ten times their thickness in both height and width. Accordingly, the room heating apparatus is a compact heating unit having high thermal efficiency, and the blower for recycling air can be protected from damage due to heat of the burner, even in the event the blower is accidentally stopped.

COMMERCIAL

32762 Utilization of LNG cold for the refrigerated warehouse. Kataoka, H. (Japan Super Freeze Co., Ltd., Tokyo); Maeda, Y. pp 8p., Session VII, Paper 6 of In Fourth international conference on liquefied natural gas. White, J.W. (ed.). Chicago; Institute of Gas Technology (1974).

From Institute of Gas Technology; Algiers, Algeria (24 Jun 1974).

See CONF-7406128—.

As the new technology of cold utilization of LNG other than liquid oxygen production which was successfully commercialized two years ago, Tokyo Gas Co., is now applying LNG Cold for a big refrigerated warehouse. It is located on the campus of Negishi Works, Tokyo Gas Co., storing frozen seafood in the temperature range of -35 and -50°C, the capacity being 28,000 m^3 using 4 lb/h of LNG. LNG Cold is first transferred to Freon which recycles between the unit cooler in the warehouse and LNG heat exchanger, keeping the room temperature as required. This process will enable curtailment of the power requirement by 50 to 60 percent as compared with the conventional refrigeration system although the magnitude of saving being not so big. The plant was put into operation in October 1974. The owner and the operator is a new company--Japan Super Freeze Co.,--a joint venture among Tokyo Gas Co., Mitsubishi Corporation, and International Marine Products Co. Features of the warehouse and the probable development of this technology are described.

TRANSPORTATION AND PROPULSION

REFER ALSO TO CITATION(S) 32732

32763 (PB—260000) **Energy and economic impacts of projected freight transportation improvements. Final report.** Leilich, R.H.; Cohen, R.D.; Gezen, A.; Kendrick, M.J. (Peat, Marwick, Mitchell and Co., Washington, D.C. (USA)). Nov 1976. Contract DOT-TSC-0094-18. 442p.

Prepared in cooperation with Battelle Columbus Labs., Ohio.

This study examines current and future energy impacts for each major freight mode, by commodity, and, in many cases, by vehicle types. It also discusses potential economic impacts of these anticipated changes. The study is limited to intercity freight movements of both private and for-hire carriers. The study includes a determination of base case energy scenarios for 1972, 1980, and 1985 to serve as a basis for evaluating operational and technological impacts by 1980 and 1985 for an industry change scenario and the government influence scenario. The report discusses in detail operational and technological changes which will have energy and economic impacts on each of the freight modes. (Portions of this document are not fully legible.)

LAND AND ROADWAY

32764 (NTIS/PS—76/0988) **Car pools (a bibliography with abstracts). Report for 1970-Nov 76.** Adams, G.H. (National Technical

Information Service, Springfield, Va. (USA)). Dec 1976. 42p. Q 01/MF/N01.

Supersedes NTIS/PS—75/854.

Studies are presented of the feasibility, methodology, and benefits of cooperative automobile use, or car pooling, in urban areas. The principal problems considered are traffic congestion, air pollution, and fuel shortages, along with the associated advantages of mobility improvement, environmental protection, and energy conservation. Several proposals are presented, such as exclusive bus and car pool lanes, community hitchhiking, Government agency preferential treatment of carpoolers, work-destination charts and listings, and computer matching of journey-to-work data. Incentives to gain motorist support, as well as difficulties to be handled regarding work shifts and travel distances are discussed. (This updated bibliography contains 37 abstracts, 16 of which are new entries to the previous edition.)

32765 (PB—259 949) **Parking management strategies for reducing automobile emissions. Final report.** Dern, J.; Cole, J.; Fallon, B.; Heller, J.; Hickey, S. (Energy and Environmental Analysis, Inc., Arlington, Va. (USA)). Sep 1976. Contract EPA-68-01-3243. 196p. Q 09/MF/A01.

This report defines the concept of parking management and explores how parking management can be used to improve air quality, support mass transit, reduce energy consumption and improve the amenities of life in urban areas. Specific aspects of this analysis were developments of a prototype parking management plan for the Washington, D.C. metropolitan area illustrating types of measures which can be used for parking management; evaluation of the socioeconomic impacts of parking measures in the plan and their effectiveness in reducing vehicle miles traveled (VMT) and improving air quality; development of a parking management planning process which integrates local and regionwide planning through the use of regional guidelines. Four target areas in the D.C. region were studied in detail: the D.C. Core, Rosslyn, Va.,Silver Spring, Md., and Centreville, Va. A regional plan was then developed from information gathered in the target area studies, including an analysis of regionwide parking related goals and problems.

PIPELINE

REFER ALSO TO CITATION(S) 31881

INDUSTRY

REFER ALSO TO CITATION(S) 32732

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 31851, 32294, 32946, 33057

32766 **Gas energy conservation research for industry: its importance and what is being done.** Larson, D.H. (Institute of Gas Technology, Chicago). pp 10p., Session VII, Paper 4 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974).

See CONF-740387—.

Considerable new technology currently is being developed to conserve natural gas in the industrial sector. Industrial processes have a significant and unique potential for reducing current energy demands. Consequently, gas industry conservation research in this area will provide benefits for both our customers and ourselves. Conserving industrial gas through the development of more efficient processes will retain industry as a valued customer and possibly provide gas for other profitable areas. This paper describes some of the general benefits of industrial energy conservation research, several development programs that are under way, and a method for improving the implementation of gas industry research.

32767 **Process for recovering energy from liquefied gases.** Pocrnja, A. (to Linde Aktiengesellschaft). US Patent 3,992,891. 23 Nov 1976. Priority date 16 Feb 1974, German, Federal Republic of (F.R. Germany). 8p.

In a process for recovering the energy from a liquefied gas by evaporation in heat exchange with a cycle medium which is simultaneously cooled, said cycle medium being thereafter compressed, heated, subjected to engine expansion and recovered in a cyclical manner, wherein the improvement comprises operating the cycle so that the cycle medium remains in the gaseous phase throughout the entire cycle.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 31768, 32283, 32766

32768 **Heat reclaim for refrigeration systems.** Kramer, D.E. US Patent 3,994,142. 30 Nov 1976. Filed date 12 Jan 1976. 10p.

The field of mechanical refrigeration and, more particularly, those refrigeration systems which are equipped with two condensers, located in two different environments are discussed. One condenser is generally outdoors, where the heat abstracted by the refrigeration system from the evaporator plus the heat representing the mechanical energy added to the refrigerant vapor in the compressor is dissipated to the atmosphere, or alternately, is dissipated to a stream of water in an evaporative or water-cooled condenser. The second condenser is generally located in some environment which periodically requires heat which would otherwise have to be supplied by burning fossil fuel or by causing electricity to flow through resistance elements. The condenser, which is located in a position where its heat can be utilized, need not be used for heating air. It could be located in the tank of a hot water heater, or wherever the heat rejected by the condenser could be effectively utilized.

RECYCLING

REFER ALSO TO CITATION(S) 31768, 32199, 32773, 32774

32769 **Shipping wastes to useful places.** Albrecht, O.W. (Environmental Protection Agency, Cincinnati). *Environ. Sci. Technol.;* **10**: No. 5, 440-442(May 1976).

The question of whether freight rates for common carriers, as regulated by the Interstate Commerce Commission (ICC), are discriminatory and discourage the movement of waste materials for recycling has been debated publicly at length, particularly in regard to the railroad movement of ferrous scrap. The Institute of Scrap Iron and Steel (ISIS) has repeatedly charged that railroad rates favor the movement and use of the virgin material (iron ore) over ferrous scrap in the making of steel. The National Association of Recycling Industries (NARI) has also argued that waste materials destined for recycling have been discriminated against by the regulated rates. The increasing interest in resource recovery and recycling has spurred new interest in the ICC's rate-making procedures. Results of studies on the rate making policies and procedures are presented.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 32732

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 31768, 32199, 32910

32770 (BNL—50577) **Development of a glass polymer composite sewer pipe from waste glass. Progress report No. 1, July—September 1976.** Kukacka, L.E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 10p. Dep. NTIS $3.50.

A program to develop methods for incorporating waste glass into composites which can be used for construction materials has been started. The goals for the program are: to provide the technical basis for energy conservation by the development, testing, and practical demonstration of products made from industrial waste materials; and to promote rapid transfer and implementation of the technology in the private sector. The program goals will be achieved by performing the following tasks: determine the properties of glass-polymer sewer pipe to a degree that they are statistically acceptable with respect to relevant ASTM methods and standards; perform field testing of prototype and full-scale specimens; prepare energy budgets and cost analyses; and involve the solid waste utilization industry in all phases of the program in order to provide a technical basis for the rapid implementation of the technology.

32771 **Resource recovery from municipal solid waste in USA: a British view.** Palmer, C. (Suffolk Cty Counc, Engl). *Chart. Mech. Eng.;* **102**: No. 6, 120-124(Jun 1975).

The paper concentrates on the trends in waste generation to present an overview of the disposal problem in US, and the more important and promising systems now in various stages of development to recover resources from municipal solid waste.

32772 **Activated carbon by pyrolysis of organic sludges.** Fasoli, U.; Genon, G. (Instituto di Chimica Industriale, Torino, Italy). *Water Res.;* **10**: No. 6, 545-547(1976).

A study of the feasibility of subjecting organic substances in waste waters to pyrolysis prior to their employment in purification of the water itself is reported. Refinery wastes and those from a biochemical industry were examined. In the case of the refinery wastes, oil filtered on sand granules was carbonized in various gas atmospheres for various periods. The quality of the carbon obtained was determined with reference to its oil-carbon transformation yield,

adsorption capacity, and residual hydrocarbon content, comparison being made with a commercial active carbon. Carbon from biochemical wastes was obtained by pyrolysis of the mycelium after fermentation and filtration. This process is promising in that an improvement in the system used for the sludges disposal is required to obtain the active carbon required for the treatment of wastes.

32773 Processing energy from wastes. Wilson, E.M. (Ralph M. Parsons Co., Pasadena, CA); Freeman, H.M. *Environ. Sci. Technol.;* **10**: No. 5, 430-435(May 1976).

New conversion technology permits the U.S. to generate a portion of its energy needs from its mounting piles of solid wastes refuse. Energy recovery is becoming so routine that the recycle material being used is no longer recognized as a waste and is listed on residual inventories. General operations of recycle facilities include shredding and classification of wastes, pyrolysis, and pollution control. The PUROX and TORRAX systems are described.

32774 Resource recovery industry. Ganotis, C.G. (MITRE Corp., Bedford, MA); Hopper, R.E. *Environ. Sci. Technol.;* **10**: No. 5, 425-429(May 1976).

Views of the resource recovery industry's present and future roles are summarized. Most industries have entered the resource recovery business to expand existing production lines, to promote concomitant services, and to broaden raw materials or energy-supply bases. Most firms will provide technology to solve the waste problem only if it can make a profit. Thirty-to-forty-thousand-tons-per-day facilities are expected by 1982. Prime industrial concerns are legal conflicts, financing, and government policy.

32775 Apparatus for the recovery of sulphuric acid from industrial waste gases. Ross, S.L.; Shuffman, O. (to Rose Shuffman). US Patent 3,994,691. 30 Nov 1976. Filed date 24 Jul 1975. 16p.

Apparatus and method for the cryothermal recovery of sulfuric acid as predicated on the capture and conversion of sulfur dioxide contained in industrial waste gases. The apparatus includes a waste gas purifier comprising a chamber through which waste combustion gases are passed so as to traverse an ice bed filter means containing ice produced so as to contain entrained oxygen by an independent ice-making machine and chilled by the use of a cryogenic material, preferably liquid nitrogen. The incoming gases may be chilled by recirculating the gases that have passed through the ice filter bed so as to chill the portion of the chamber that is contacted by the incoming gases prior to their passage through the ice filter bed. Oxygen entrainment may be enhanced by the employment of a source of oxygen and the entrained oxygen at the low temperature provided by the ice bed reacts with sulfur dioxide contained in the waste combustion gases by transition through sulfur trioxide to sulfuric acid. The sulfuric acid is contained in melt from the ice filter bed and may be washed out with a spray of cold water.

32776 Treatment of waste products from Portland Cement Manufacture. Watson, D.; Brown, A.W. (to Associated Portland Cement Manufacturers Ltd.). US Patent 4,001,030. 4 Jan 1977. Priority date 28 Feb 1974, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

A process of treating kiln flue dust from Portland cement manufacture which comprises calcining said flue dust together with a minor proportion by weight of a fluoride salt is described.

32777 Sulfur recovery system. Sanders, F.W. (to Mead Corp.). US Patent 4,001,385. 4 Jan 1977. Filed date 21 Jun 1974. 12p.

Recovery of chemicals from a sodium sulfide containing pulping liquor which is cycled from a digester through a recovery system is effected by separating hydrogen sulfide gas, either from the cooking liquor or from various points in the recovery system, to provide a source of sulfide sulfur which is oxidized to sulfur. When separated from the cooking liquor, it is preferred that the hydrogen sulfide gas be taken from the black liquor, prior to combustion, so as to reduce the sulfidity of the liquor being burned and thereby to reduce sulfur losses in the combustion furnace and effect reduction of sulfur pollutants. Oxidation of the hydrogen sulfide gas is carried out in an aqueous medium, in the presence of a wetproofed catalyst and using air or other oxygen containing gas as the oxidant. Sour hydrocarbon gases containing hydrogen sulfide gas may also be processed in accordance with this invention to convert the sulfide sulfur to products such as elemental sulfur, sodium polysulfide and the like.

32778 Process for recovery of oxides of sulfur from combustion waste gas. Iwakura, J.; Sato, K.; Fujii, H.; Hashimoto, Y.; Ono, S.; Watanabe, S.; Yokoyama, A. (to Asahi Glass Co., Ltd.). US Patent 4,001,384. 4 Jan 1977. Priority date 1 Aug 1972, Japan. 8p.

A process for the recovery of oxides of sulfur from combustion waste gases, which comprises cooling said waste gases and forming entrained particles of sodium compounds, consisting essentially of sodium carbonate, by spray contact with sodium hydroxide or sodium carbonate, converting sodium carbonate in the particles to sodium sulfate by passing said oxides of sulphur containing waste gases and said sodium compound particles over plate-like packings, whereby said particles are comminuted to a finer particle size form so as to enhance the reaction of said sulfate particles with the oxides of sulfur in said waste gases, collecting entrained particles of said sodium compounds in a dust collector.

32779 Fertilizer processes incorporating scrubbed flue gas sludge byproduct. Schultz, J.J.; Van Pelt, V.J. (to Tennessee Valley Authority). US Patent T955,002. 1 Feb 1977. Filed date 23 Feb 1976. 3p.

A process is described for the production of a granular fertilizer material from sludge materials discharged from scrubbing processes that remove pollutants from boiler flue gases. Waste sludge discharged from flue gas scrubber systems often contains large amounts of calcium and sulfur as well as lesser amounts of other compounds known to have plant nutrient value. The sludge is treated with an acid such as phosphoric, sulfuric or nitric, or a mixture of these, and ammonia. The resulting sludge-ammonia-acid salt mixture is combined with partially dried, previously solid material (recycle) in a horizontal rotating vessel. Additional ammonia and/or acid is added to the rotating vessel to cause the sludge-salt mixture to solidify and granulate. Other plant nutrients may be added to the rotating vessel during granulation. The granulated material discharged from the rotary vessel is further processed (dried, cooled, and screened) to obtain desirable moisture content and particle size.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

DIESEL

REFER ALSO TO CITATION(S) 32790

32780 HST on the Western region. *Diesel Eng.;* **72**: No. 791, 211-215(Win 1976).

A design and development program for British high-speed diesel trains is described. Prototype testing showed that service operation at 200 Km/hr (125 mph) was possible, and several trains are in current use, with production planned for more. A discussion is given of the design philosophy, engine auxiliaries, electrical machinery, auxiliary power, novel traction motor drive, modifications to the prototype, and maintenance. (PMA)

32781 Now the diesel family car. *Diesel Eng.;* **72**: No. 791, 253-255(Win 1976).

A description is given of the design and production of the diesel engine for the Volkswagen Golf which was developed to meet the stringent emission regulations in the USA. Although the engine is reported to be extremely free-revving, the fuel consumption figures appear to be extremely low, on the order of 40 to 60 mpg (steady-state conditions), depending on engine size and speed. Tests have shown that the 1471 cm^3 Golf diesel can meet US Federal emissions legislation proposed for the 1980's, without requiring additional control systems such as catalytic converters and exhaust recirculation systems. (PMA)

32782 Influence of fuel properties on the injection characteristics of fuel injection system in diesel engines. Maeda, Y.; Murayama, T.; Fukazawa, S. (Nippon Min. Co., Saitama, Japan). *Bull. JSME (Jpn. Soc. Mech. Eng.);* **18**: No. 118, 411-418(Apr 1975).

Experimental studies on the effect of fuel properties on fuel injection and spray characteristics of a diesel engine using a Bosch type injection pump show that a vapour cavity formation phenomenon appeared in the pump barrel with a decrease of fuel feed pressure and fuel properties, e.g., fuel viscosity, compressibility, acoustic velocity, etc. considerably influenced the injection quantity, injection timing, injection rate and spray characteristics. Especially, it was noted that these tendencies are notable in lighter fuel such as gasoline.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 32787

32783 (UCRL-Trans—11210) Possibilities for regenerative braking of dc traction vehicles. Wagner, R. Translated from *Siemens-Z.;* **46**: No. 8, 692-699(1972). 26p. Dep. NTIS $4.00.

Since electrical traction was introduced into rail traffic, it has always been the goal to convert the kinetic energy of the vehicles during braking into electrical energy and to feed that back into the

railway electrical system. However, the great expense required for the vehicles, the lack of means for fast control and the small regenerative effect achievable heretofore have rendered difficult or have completely impeded the introduction of the regenerative brake on a wide basis. It is only recently that power electronics, with which any energy flow can be controlled and regulated arbitrarily by means of thyristors, has opened new possibilities for electrical regenerative braking in dc traction vehicles. This relates not only to the vehicle equipment but also to the power supply systems of the contact-line electrical systems. Thus, if new analyses are to be made of regenerative braking of electrical traction vehicles, then, besides the vehicle facilities, it is also necessary to investigate the problems of transmission and reuse of the fed-back energy.

32784 Superconducting MAGLEV test facility for high speed transport. Rhodes, R.G.; Mulhall, B.E. (Warwick Univ., Coventry, Eng.). pp 489-491 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A 550 m long straight track for research into magnetically levitated vehicles has been constructed at the University of Warwick. The flat guideway comprises two strips of aluminium, interacting with the vehicle borne superconducting magnets to produce both lift and guidance. For propulsion a petrol driven winch is provided, though it is to be replaced later by a linear electric motor. Problems of engineering cryostats for magnetic levitation are briefly discussed.

32785 Electrical cars: more push down under. Whitford, D. (Flinders Univ., South Australia). *Electr. Rev.;* **199**: No. 22, 34(3 Dec 1976).

A brief description is given of advances in the design of electric vehicles. Transmissions and control systems were redesigned so that the mechanical requirements of the vehicle road wheels are matched to those of the electric motor, and the electrical requirements of the motor are matched to those of the power source. A preselector unit controls the battery voltage in 12 V increments to track the back e.m.f. of the motor as the vehicle speed varies. (PMA)

32786 Electric car may be energy saver in 2001. Charlesworth, G. (Open Univ., Milton Keynes, Eng.). *Electr. Rev.;* **199**: No. 23, 16-17(10 Dec 1976).

A comparative evaluation is made in terms of primary energy efficiency of internal combustion engine automobiles and electric-powered vehicles for both present and projected future models. The sodium sulfur battery appears to be the front runner among battery candidates and is expected to achieve an energy density of about 550 MJ/ton. It is predicted that electric cars will be on the order of 1.7 times more efficient than combustion powered automobiles in their use of primary energy when moving the average payload. (PMA)

HYBRID SYSTEMS

32787 (COO—4010-1) **Demonstration of an inductor motor/alternator/flywheel energy storage system. Quarterly progress report No. 1, June 28, 1976—September 28, 1976.** (General Electric Co., Schenectady, N.Y. (USA)). 28 Sep 1976. Contract EY-76-C-02-4010. 47p. Dep. NTIS $4.00.

Vehicle propulsion concepts utilizing flywheel energy are described. Analyses are presented for sizing an inductor motor/alternator/flywheel for application to a 3000 pound vehicle. Component tradeoffs are included for the inductor motor/alternator drive, the solid state inverter/rectifier, the control circuit, and a composite flywheel. Design specifications for the machine are established and a test plan defined.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 32787

32788 Utilization of flywheel energy and its problems. Imai, H. *Denki Shikensho Iho;* **40**: No. 10, 853-877(1976). (In Japanese).

The application of flywheels to cars and power supply systems was studied from the viewpoint of reducing the exhaust emissions from cars and enhancing economic conditions of the power systems. By referring to various literature, the feasibility of flywheels was investigated and technical problems on their practical use were studied. It was found possible for the current technology to develop practical flywheel cars in a specific field of usage, such as buses, as well as to develop flywheel hybrid cars for wider use. Though it is technically possible to develop flywheel regulators for peak loads, there still remain economic problems difficult to solve before putting them into practical use.

32789 Utilization of flywheel energy and its problems. Imai, H. *Denki Shikensho Iho;* **40**: No. 11, 930-954(1976). (In Japanese).

The application of flywheels to cars and power supply systems was studied from the viewpoint of reducing the exhaust emissions from cars and enhancing economic conditions of the power systems. By referring to various literature, the feasibility of flywheels was investigated and technical problems on their practical use were studied. It was found possible for the current technology, to develop practical flywheel cars in a specific field of usage, such as buses, as well as to develop flywheel hybrid cars for wider use. Though it is technically possible to develop flywheel regulators for peak loads, there still remain economic problems difficult to solve before putting them into practical use.

VEHICLE DESIGN FACTORS

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 32791

32790 Road vehicles for world markets. Williams, D.S.D. *Diesel Eng.;* **72**: No. 791, 222-234(Win 1976).

A review is given of recent designs of British commercial vehicle diesel engines. Topics discussed include fuel economy, turbocharging, power, torque, and load capacity. Diesel engines for automobiles and trucks from twenty-five manufacturers are described. (PMA)

EMISSION CONTROL

REFER ALSO TO CITATION(S) 32765, 33145

32791 (PB—255496) **Emissions from diesel and stratified charge powered cars. Final report.** Springer, K.J. (Southwest Research Inst., San Antonio, Tex. (USA)). Dec 1974. Contract PH-22-68-23. 333p. (SWRI-AR—975). NTIS (US Sales Only).

A total of ten passenger cars, four powered by diesel engines, two by stratified charge gasoline engines, one by a stratified charge operating on gasoline and diesel fuel, two by control equipped conventional engines, and one powered by a gas turbine, have been subjected to a wide variety of emissions evaluations. The vehicles, all late model, low mileage, included a Nissan Datsun, a Mercedes 220D, a Peugeot 504D, an Opel Rekord 2100D, a standard Capri, a stratified charge (PROCO) Capri, a low emission prototype Ford LTD, the Texaco TCCS stratified charge powered Cricket operated on gasoline and on diesel fuel, a Honda CVCC stratified charge, and a Chrysler gas turbine car. All were 4-cylinder except the LTD and the gas turbine. Tailpipe emissions were measured by the 1975 light duty Federal Test Procedure for gaseous emissions. Smoke and fuel economy were also determined during this test cycle. Odor and related instrumental-chemical measurements were made under seven steady state and three acceleration conditions. Noise measurements were taken by SAE driveby as well as under a variety of exterior-interior conditions. Comparisons of the results for all vehicles are by emission category. The emissions from the group of diesel cars are compared to the conventional gasoline, Ford PROCO, Texaco TCCS, and Honda CVCC. (GRA)

32792 Calibration gas standards. McNesby, J.R.; Hughes, E.E. (NBS, Washington, DC). *Adv. Instrum.;* **29**: 1-5(1974).

The National Bureau of Standards has developed a number of gas Standard Reference Materials during the past two years for the measurement of pollutant gases in automobile exhaust emissions. These Standard Reference Materials include carbon monoxide in nitrogen, propane in air, carbon dioxide in nitrogen and nitric oxide in nitrogen at concentrations relevant not only to auto exhaust emissions but also to aircraft exhaust emissions. The technical problems associated with the development of those Standard Reference Materials are discussed and a description of the ranges of concentrations available is outlined.

32793 Exhaust gas cleaner. Miyamori, Y.; Masaki, K.; Nambu, S. (to Nissan Motor Co., Ltd.). US Patent 3,992,879. 23 Nov 1976. Priority date 30 Nov 1972, Japan. 6p.

Exhaust gas is passed through a thermal reactor at high exhaust gas temperature and flow rate, and through a catalytic converter at low values of these parameters. Alternatively, exhaust gas may be passed through the thermal reactor at high values of the parameters, and through both the thermal reactor and the catalytic converter at low values.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 32781, 33146

32794 Apparatus for treating engine exhaust gases. Roberts, A.L.; Adelkoff, S. US Patent 3,988,113. 26 Oct 1976. Filed date 17 Aug 1973. 10p.

An apparatus is described for treating engine exhaust gases for the effective removal of carbon monoxide, hydrocarbons and/or the oxides of nitrogen from the exhaust system of mobile internal combustion engines. A readily accessible exhaust treating tube in the engine exhaust pipe system contains a removable and disposable open end cartridge which, in turn, contains a fibrous filter which is impregnated with a chemical solution for treating the exhaust gases. The disposable cartridge may be easily replaced at regular intervals by simply removing the spent cartridge and inserting a new one.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 32781, 32794

32795 Motor vehicle pollution control suspension request. Extension of public hearing. Strelow, R. *Fed. Regist. (Wash., D.C.);* **40**: No. 32, 6820-6821(14 Feb 1975).

The extension of public hearings on the request to suspend statutory 1977 light duty vehicle emission standards is announced. Data are requested on these topics: the increase in human exposure to sulfuric acid or other sulfate pollutants anticipated to result from continued use of automotive oxidation catalysts; the health effects associated with exposures to such levels of these pollutants; and the health trade-off between achieving reductions in automotive emissions of hydrocarbons, carbon monoxide, and other possible substances through application of oxidation catalyst emission control systems while incurring increased exposures to emissions of sulfate compounds or other emission products. Testimony is sought on the feasibility of achieving interim reductions in automotive sulfate emissions levels through the selective blending by refineries of low sulfur gasoline components into unleaded grades required by catalyst-equipped vehicles and the possible allocation of such low sulfur unleaded gasoline supplies to geographical areas anticipated to experience the greatest impact from automotive sulfate emissions.

SULFUR DIOXIDE

REFER ALSO TO CITATION(S) 32297, 32795

HYDROCARBONS

REFER ALSO TO CITATION(S) 32781, 32794, 32795

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 31934

32796 (AD—A031885) **Fuel and lubricant compatibility studies for army high-output two-cycle diesel engines. Interim report Sep 72-Sep 75.** Lestz, S.J.; Bowen, T.C.; LePera, M.E. (Southwest Research Inst., San Antonio, Tex. (USA). Army Fuels and Lubricants Research Lab.). Sep 1976. Contracts DAAD05-70-C-0250;DAAK02-73-C-0221. 49p. (AFLRL—80). Q 03/MF/A01.

Also available as SAE paper 760717. Includes Contract DAAG53-76-C-0003.

A high-output Army two-cycle diesel engine was subjected to proving-ground related laboratory-dynamometer endurance test cycles using four different qualified MIL-L-2104C SAE grade 30 lubricants. Three diesel fuels differing mainly in sulfur level and end point temperature were an important part of the test matrix. Two lubricants (low- and mid-ash level) produced acceptable performance and a third (of high-ash level) was considered borderline acceptable--all during operation with reference No. 2 diesel fuel (0.42% wt sulfur). A fourth oil (low-ash level) was judged to be incompatible due to its proneness to severe piston and liner scuffing. The engine was judged incompatible with a high sulfur/high endpoint (1.2%S/396 C (744 F) EP) fuel intended to meet MIL-F-16884F (Marine Diesel Fuel) using two different MIL-L-2104C lubricants. This engine was also judged to be incompatible with a special blend to NATO F-54 diesel fuel (0.64% sulfur) during operation with the same two lubricants. Incompatibility using fuel sulfur levels greater than 0.50% was based on the occurrence of catastrophic piston/ring/exhaust valve failure and relatively high deposit and wear levels.

32797 (AD—A032075) **Performance of army engines with unleaded gasoline-field study evaluation. Final report.** Tosh, J.D. (Southwest Research Inst., San Antonio, Tex. (USA). Army Fuels and Lubricants Research Lab.). Oct 1976. Contracts DAAK02-75-C-0082;DAAD05-72-C-0427. 114p. (AFLRL—82). Q 06/MF/A01.

All gasoline-powered vehicles and equipment at six U.S. Army installations were operated during the evaluation period on VV-G-001690A Regular Grade unleaded gasoline. Special Grade 91.0 RON unleaded gasoline was specified but was unavailable; therefore, unleaded gasoline in the 92.0 to 94.0 RON range was used through out the program. During this evaluation period, no detrimental effects were noted on material handling equipment (MHE), engineer support equipment, or commercial, tactical, or combat vehicles operated under typical daily military operation. Also, no increases in maintenance operating costs were noted during this evaluation.

32798 Motor fuel composition. Rosenthal, J.W.; Kozlowski, R.H. (to Chevron Research Co.). US Patent 3,988,122. 26 Oct 1976. Filed date 30 Jun 1975. 4p.

A motor fuel comprising 85 to 99 vol % gasoline-boiling-range hydrocarbons and 1 to 15 vol % oxylate is described. The oxylate consists of tertiary butyl alcohol, isopropyl alcohol, and methyl alcohol. Preferred composition for the oxylate is about 20 to 90 vol % tertiary butyl alcohol, 5 to 40 vol % isopropyl alcohol, and 5 to 40 vol % methyl alcohol. The oxylate improves the octane of the gasoline-boiling-range hydrocarbons more than expected, and the motor fuel containing oxylate is an excellent unleaded gasoline.

MATERIALS

32799 Raman spectroscopic studies of yttrium (III) chloride—alkali metal chloride melts and of Cs_2NaYCl_6 and YCl_3 solid compounds. Papatheodorou, G.N. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **66**: No. 7, 2893-2900(1 Apr 1977).

The Raman spectra of molten YCl_3—A Cl (A=Cs, K, Li) mixtures have been measured at different compositions and temperatures up to 890 degreeC. The Raman spectra of polycrystalline Cs_2NaYCl_6 and YCl_3 were also measured from 25 degreeC to temperatures above melting. The factor group analysis of crystalline Cs_2NaYCl_6 was used to identify the three Raman active modes (ν_1, ν_2, ν_5) of the YCl_6^{-3} octahedra. For liquid mixtures rich in alkali halide, the predominant features of the spectra are characterized by a polarized and a depolarized band with frequencies near the ν_1 and ν_5 frequencies of the YCl_6^{-3} octahedron and thus indicates the existence of such species in the melt. In melts containing above 25% YCl_3 a new polarized band D appears in the spectra which shifts continuously and rapidly to higher energies with increasing YCl_3 concentration. The frequency shift is attributed to a continuous distortion mechanism of the YCl_6^{-3} octahedra by the neighboring yttrium ions. The continuous frequency shift of the D band and a comparison of the liquid and solid Raman spectra of yttrium chloride suggest the existence of lattice-type modes in these melts.

METALS AND ALLOYS

32800 (JAERI-M—6281) **Molten metal dropping experiment. Initiation criteria of the metal fragmentation in molten metal-water interaction.** Fujishiro, T.; Ochiai, M. (Japan Atomic Energy Research Inst., Tokyo). Oct 1975. 21p. (In Japanese). NTIS (US Sales Only).

Understanding of molten fuel-coolant interaction, i.e. the mechanical energy generation at fuel failure is one of the main objectives of NSRR fuel failure experiments. To analyze this phenomenon there are many unknown parameters such as molten fuel fragment size, fuel-coolant mixing rate and heat transfer coefficient between molten fuel and coolant. Among these parameters, initiation of the fuel fragmentation is one of the important criteria to decide whether or not large mechanical energy shall occur. The present work is a simulation experiment to find out the thermal conditions for fuel fragmentation using molten metal/water combination in stead of molten UO_2/water. Four different metals, Sn,Pb,Al and Sn50%-Pb50% alloy, were used as simulation material of UO_2. The material was heated to a temperature above its melting point in an electric furnace, then dropped into a temperature-controlled water pool from a little above the water surface. Molten metal temperature and water subcooling were varied in the experiment. The following results were obtained. (1) Fragmentation occurred in low melting-point metals, i.e. Sn,Pb and Sn-Pb alloy. (2) In low melting point metal fragmentation, the metal temperature threshold and the water subcooling threshold were obserbed. That is no fragmentation occurred when the metal temperature was lower than about 100°C above the melting point or when the water subcooling was smaller than 40°C. (3) The threshold subcooling increased with the increase of molten metal temperature. (4) No fragmentation took place in molten Al/water interaction in our experiment system at pool water temperature 0 - 100°C and metal temperature 685 - 1200°C.

32801 Presenting stress-strain data for ASME code design analysis. Harman, D.G. (Westinghouse Electric Corp., Tampa, FL). pp 85-107 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

Section III of the Code now allows plastic analysis using stress-strain curves. This paper describes a test program now underway at Westinghouse to determine the stress-strain behavior of PWR steam generator materials. A data format is presented which meets the specific needs of design analysis while still allowing the illustration of "real" deformation behavior rather than computer generated equations, curves, and digital printout. The format incorporates the uncluttered illustration of triplicate test data, S/sub y/ and S/sub u/ values familiar to the analyst, and results of statistical treatment of test data from the literature and from vendors' mill reports. Completed stress-strain curves are shown for austenitic and ferritic alloys at test temperatures up to 700°F (371°C).

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 32417, 32974, 32976, 32977, 32978, 32979, 33056

32802 (LBL—6019) **Modeling of the electrochemical machining process.** Riggs, J.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1977. Contract W-7405-ENG-48. 125p. Dep. NTIS $5.50.

Thesis.

A computer-implemented model for predicting electrochemical machining (ECM) work piece geometry was developed and then verified by electrochemically sinking holes in copper and 302-stainless steel using a commercial ECM machine. A tool piece of cylindrical symmetry was chosen because it provided a two-dimensional problem and also because of its mechanical simplicity. The model was developed to predict the dependence of ECM work piece geometry on the operating conditions of the process (i.e., electrolyte conductivity, applied voltage, and tool piece feed rate) and on the physical and electrochemical characteristics of the electrodes (e.g., anodic current efficiency, reversible cell potential, and charge transfer overpotential). The operating conditions for the electrochemical machining of copper were adjusted to avoid any part of the anode being in the transpassive region because of the lack of quantitative data describing the anodic films formed during transpassive dissolution. Because neither the reversible cell potential nor the charge transfer overpotential of the electrodes was known for the systems under consideration, an estimate of their combined effect was deduced from several experimental profiles. This empirically determined estimate of the potential drop excluding IR drop was found to be in reasonable agreement with the theoretical predictions. The empirically determined estimate was used by the model in the prediction of eight equilibrium ECM cuts and of six unsteady-state profiles for copper and gave satisfactory correspondence with experiment. A similar approach was used for model predictions for 302-stainless steel. A method of correlating characteristics of equilibrium ECM cuts with the operating variables was also presented. This method can be used to predict the operating conditions which yield the desired cut dimensions.

32803 (NTIS/PS—76/0723) **Diffusion bonding (a bibliography with abstracts). Report for 1964-Sep 76.** Reed, W.E. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 167p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/771.

The processing, metallurgical techniques, diffusion phenomena, bonding mechanisms, and mechanical properties of diffusion bonded joints are investigated in the cited reports. Materials bonded include stainless steels, refractories, titanium, dissimilar metals, composites, reactor fuels, and silicon wafers. (This updated bibliography contains 162 abstracts, 20 of which are new entries to the previous edition.) (GRA)

32804 (NTIS/PS—76/0724) **Inert gas welding (citations from the NTIS data base). Report for 1964—Aug 76.** Reed, W.E. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 140p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/764. See also NTIS/PS-76/0725, and NTIS/PS-76/0726.

The Federally sponsored research reports cited deal with the development of techniques and procedures for inert gas welding and with the characteristics of the resulting welds. Process control, automation, nondestructive testing, and health hazards are also investigated. Metals welded include steel, titanium, aluminum, uranium, and refractory metals. (This updated bibliography contains 135 abstracts, 22 of which are new entries to the previous edition.) (GRA)

32805 (SIGMAO-nn—1) **Solidification microstructure and texture of fusion welded platings made of chromium—nickel steels for nuclear reactor components.** Schmitt-Thomas, K.G.; Doffin, K.; Ruckdeschel, W. Translated from *Schweissen Schneiden;* **26**: No. 2, vp(1974). 9p. (In Czech). TIC.

Translated from Schweissen Schneiden (1974) v. 26(2). Available from Sigma Olomouc, Olomouc, Czechoslovakia.

An investigation was made on 18 different platings prepared by submerged arc welding with band electrodes made of X3 CrNiNb 24 12 or using the plasma filament method with two "hot wires" of X2 CrNiNb 22 11. A report is given on the influence of the welding conditions on the crystallite inclination and texture and on relationships between anisotropy and material properties.

32806 **Incoloy alloy 800 tubing for service at 538°C in nuclear steam generators.** Bassford, T.H. (Huntington Alloys, Inc., WV). pp 282-289 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

The results of recent experiments indicate that production of alloy 800 tubing which would have tensile-limited design stresses at temperatures over 538°C (1000°F) is possible. The use of such tubing would eliminate costly time-dependent stress analysis in steam-generator design. At temperatures to at least 538°C (1000°F), the experimental product, which is produced by subjecting the tubing to light cold work followed by a nonrecrystallizing anneal, would exhibit higher yield strength and creep-rupture strength than annealed or coarse-grained annealed material.

32807 **Tungsten—nickel—iron—molybdenum alloys.** Grierson, R.; Larsen, E.I. (to P.R. Mallory and Co., Inc,). US Patent 3,988,118. 26 Oct 1976. Filed date 10 Mar 1975. 10p.

This invention is directed to the use of tungsten base alloys containing about 1 to 12 wt. percent nickel, about 0.5 to 8 wt. percent iron, and about 0.5 to about 25 percent molybdenum and at least one additional additive selected from cobalt, chromium, manganese, vanadium, tantalum, zirconium, titanium, yttrium, rhenium, boron, and silicon. Chromium may substitute for molybdenum up to 15 percent. In addition to being useful for high-density applications, structural applications, and high-temperature applications, the alloys may be used for die casting dies, molds, cores, and other metal-shaping members. 6 figures, 1 table.

32808 **Permanent magnet on the basis of cobalt—rare earth alloys and method for its production.** Strnat, K. (to Th. Goldschmidt AG). US Patent 3,998,669. 21 Dec 1976. Filed date 14 Aug 1975. 24p.

A permanent magnet is disclosed which exhibits pronounced ductility combined with a mechanical strength satisfactory for many applications and which can be machined with conventional steel tools. The magnet is formed by compacting at least one magnetic powder comprising a cobalt—rare earth alloy admixed with a metallic binder. The binder is a solder of a melting point below 400°C and bonds the particles of the magnetic powder. Procedures for forming the novel magnets are also disclosed. 5 figures, 4 tables.

32809 **Metal alloy.** Kosteruk, V.P.; Kovalchenko, M.S. US Patent 3,998,632. 21 Dec 1976. Filed date 5 Dec 1974. 10p.

Infusible metal alloys are employed both as a parts material and as a brazing spelter for the connection of various parts and components made of materials based upon infusible metals and compounds, ceramics, graphite, and the like. The alloys are based upon hafnium to which is added some elements selected from the subgroup B of the first group of the periodic system and some elements featuring melting points lying above 600°C selected from the third to eighth groups of the periodic system. 1 table.

32810 **Auger electron spectroscopic depth profiling techniques applied to ultrathin electrochemically deposited metal layers.** Knotek, M.L.; Quinn, R.K.; Armstrong, N.R.; Vanderborgh, N.E. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Vac. Sci. Technol.;* **14**: No. 2, 705-710(Mar 1977).

The Auger electron spectroscopic depth profiling technique is applied to the study of the initial equivalent monolayer of electrodeposited Ag on thin-film Pt electrodes. The ultimate depth resolution of this technique is determined by examining ultrathin layers of Ag which have been ion deposited from a zeolite source in ultrahigh vacuum. The exponential decay apparent in the examination of such layers is explained from elementary considerations of the sputtering process. These are seen to be the resolution-limiting factor for these layers. The depth resolution is shown to be on the order of 5 A. Examination of monolayer and submonolayer films of Ag electrodeposited from an $AgClO_4$/sulfolane solution shows that there is an adsorbed overlayer of S (of solvent origin) followed by the electrodeposited Ag film, which is rich in Cl (of solute origin), followed by the Pt substrate, which also contains high levels of Cl. The absence of underpotential deposition is clearly demonstrated. There appears to be two chemical states of Cl present which are distinguished by their relative thermal stabilities.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 32805, 32813, 32825

32811 Highly oriented niobium and vanadium films on sapphire. Komashko, V.A.; Silich, N.N.; Popov, V.I.; Tkachuk, B.V. *Sov. Phys. - Crystallogr. (Engl. Transl.);* **21**: No. 6, 714-715(Nov 1976).

The influence of substrate condition and evaporation parameters on the development of structure in single crystal niobium and vanadium films condensed in vacuum onto sapphire substrates has been investigated by electron diffraction. (AIP)

32812 The surface composition of Au—Sn alloys determined by Auger electron spectroscopy. Overbury, S.H.; Somorjai, G.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **66**: No. 7, 3181-3188(1 Apr 1977).

The Auger spectra of clean and equilibrated Au—Sn alloy ingots of bulk composition ranging between 50 and 99 at% Au have been obtained. The intensity ratios of Auger peaks of various different energies were normalized by comparison with the corresponding intensity ratios from pure Au and Sn. The normalized intensity ratios are used to obtain the surface atom fractions by applying a model which takes full account of the attenuation of the Auger electrons. It is found that for a one phase alloy with overall composition of 50 at% Au there is little or no segregation at the surface, while for a one phase alloy with bulk composition of 86 at% Au there is marked segregation of Sn (surface monolayer composition of about 43 at% Au). For the alloys of bulk compositions between 50 and 86 at% Au in which both phases are present, the surface composition is given by applying the lever rule to the one phase surface compositions. For 1 at% Sn dissolved in the Au lattice there is also considerable enrichment of the surface with Sn (surface monolayer composition of about 46 at% Au). These surface compositions are related to the properties of the bulk phase diagram and are explained by the interplay of the differences in atomic size and in heats of sublimation of pure Au and Sn and of the heats of mixing of the alloys.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 31778, 32314, 32629, 32827, 32855

32813 (AD—A032136) **Study of intermetallic compounds. Final report 17 Feb 75—17 Feb 76.** Rhodes, C.G.; Evans, A.G.; Paton, N.E. (Rockwell International Corp., Thousand Oaks, Calif. (USA). Science Center). Jun 1976. Contract F33615—75-C-1090. 67p. Q 04/MF/A01.

This report describes results of mechanical property tests and microstructure studies on a series of alloys based on the intermetallic compounds Ti_3Al (alpha 2) and TiAl (gamma). This class of alloys has shown considerable promise for high temperature applications and the objective of this program has been to study the microstructure of a series of alloys containing both the alpha 2 and gamma phases with a view to improving the mechanical properties. It has been shown that a variety of microstructures can be produced in a Ti—26% Al — 10% Nb base alloy, either by addition of ternary and quaternary alloying elements, or by heat treatment. (GRA)

32814 (CONF-770601—1) **Fatigue crack morphology in 304 stainless steel cycled at constant stress amplitude.** Turner, A.P.L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 10p. Dep. NTIS $3.50.

From 4. international conference on fracture; Waterloo, Canada (19 Jun 1977).

A study is made to determine which modes of nucleation and propagation are operating during elevated temperature fatigue of 304 stainless steel. Cracks are nucleated at coarse slip bands, and microstructural features such as inclusions and grain boundaries are not important either as sites of initiation or as obstacles to propagation. One of the major effects of stress amplitude is that the number of cracks nucleated increases rapidly in part because increasing the stress amplitude increases the number of grains which contain coarse slip bands, but there is sufficient data to determine if the crack density increases simply in proportion to the slip-band density or if the slip bands also become more intense and more likely to nucleate cracks at the higher stress amplitudes. The increased density of cracks appears to have significant consequences for the crack propagation process because link up of independently nucleated cracks becomes a prominent mode of propagation along the surface at the higher stress amplitudes. The process of crack linkup may not have had a large effect on the fatigue life of the specimens used in this study because the distance between independent nucleation sites on the fracture surface was never less than about a third of the critical crack size even at the highest stress amplitudes. However, this mode of propagation could have a large effect on the crack propagation portion of the fatigue life of large components, particularly when they have large surface area to volume ratios like plates and pipes.

32815 Correlation and extrapolation of creep ductility data for four elevated-temperature structural materials. Booker, M.K.; Brinkman, C.R.; Sikka, V.K. (Oak Ridge National Lab., TN). pp 108-145 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

The amount of deformation that a component can successfully endure without incurring failure-inducing damage can be a useful limit in elevated temperature design. Treatment of experimental creep ductility data by a parametric analysis technique allows the prediction of such limits. Application of such a method to data for various ductility indices for four elevated-temperature structural materials is presented, including a discussion of the results. Materials studied include types 304 and 316 stainless steel, 2¼ Cr-1 Mo steel, and Inconel Alloy 718.

32816 Creep and tensile properties and constitutive equations for a 2¼Cr—Mo steel. Bynum, J.E.; Ellis, F.V.; Roberts, B.W. (Combustion Engineering, Inc., Chattanooga). pp 146-166 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

This paper reports the creep and tensile properties of a normalized and tempered 2-¼ Cr-1 Mo forging. The tensile tests were conducted from 70 to 1100°F (21 to 593°C). The creep tests covered stresses from 4 to 42 ksi (28 to 290 MPa) at temperatures from 850 to 1250°F (454 to 677°C). From the tensile data, two constitutive equations relating true stress-true plastic strain were developed. For temperatures at or below 850°F (454°C), a modified power law which has a finite initial rate of hardening was used. For temperatures above 850°F (454°C), a combination of a modified power law plus exponential was used. From the creep data, isochronous stress-strain curves were generated for times as long as 10^4 hours. These curves were extrapolated to 10^5 hours using a parametric analysis method and a log-log extrapolation procedure. Both methods correlate well with the original data and the extrapolations agree at all temperatures except 950°F (510°C). From the creep-rupture data, temperature and stress independent correlations of rupture time with both minimum creep rate and time to onset of tertiary were determined. A creep constitutive equation was developed in which time may be expressed explicitly as a function of creep strain. Therefore, a noniterative strain hardening rule formulation can be employed by finite element stress analysis computer programs. A correlation of the creep constitutive equation model parameter with rupture time enables the entire creep law to be written as a function of rupture time and temperature. Isochronous stress-strain curves calculated from the creep law were in good agreement with the observed data.

32817 Effect of hold-time on elevated temperature fatigue crack propagation in fast neutron irradiated and unirradiated type 316 stainless steel. Michel, D.J.; Smith, H.H.; Watson, H.E. (Naval Research Lab., Washington, DC). pp 167-190 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

The effect of combined cyclic and static loading on crack propagation in EBR-II irradiated and unirradiated Type 316 stainless steel was investigated at 800 and 1100°F (427 and 593°C). Both solution-annealed and 20 percent cold-worked materials were studied. The results show that 0.1 and 1 minute hold-times and/or neutron irradiation did not significantly alter the fatigue crack growth behavior at 800°F. At 100°F, the effect of hold-time and neutron irradiation was to markedly increase crack growth rate for both material conditions. The results were evaluted on the basis of the effect of time-dependent deformation processes, cyclic frequency, and test environment. It was concluded that thermal recovery, possible time-dependent deformation, and reduced ductility contributed to the increased crack growth in the unirradiated and ERB-II irradiated material during hold-time tests at 1100°F (593°C).

32818 Monotonic and cyclic stress-strain response of annealed 2¼Cr—1Mo steel. Jaske, C.E. (Battelle Columbus Labs., OH); Leis, B.N.; Pugh, C.E. pp 191-212 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

The stress-strain response of isothermally annealed 2¼ Cr-1 Mo steel under monotonic and cyclic loadings has been characterized at temperatures from 21 to 593°C (70 to 1100°F). Monotonic stress-strain curves were developed for uniaxial tensile loading of specimens at strain rates of 8.33×10^{-5} and 8.33×10^{-6} sec^{-1} (0.005

and 0.0005 min^{-1}). The cyclic stress-strain response was measured for the first 100 fully reversed strain cycles at strain ranges between 0.4 and 3.0 percent under uniaxial loading at a strain rate of 8.33 x 10^{-5} sec^{-1}. The effects of creep, stress-relaxation, and thermal-exposure hold periods on the cyclic stress-strain behavior were also investigated at 510°C (950°F). Monotonic stress-strain curves were quantified using a power law relation between stress range and plastic-strain range (a range equals twice the amplitude). Cyclic hardening was observed at temperatures up to 427°C (800°F). A mixture of initial cyclic hardening followed by later cyclic softening was seen at temperatures from 482 to 538°C (900 to 1000°F), and cyclic softening was observed at 593°C (1100°F). For the strain ranges investigated, the cyclic stress-strain response was analyzed in terms of the ascending path of the stress-strain hysteresis loop for the tenth cycle. These cyclic stress-strain paths were approximated by a translation of the monotonic curve along the elastic modulus line. This empirical model then provides a representation of the monotonic and cyclic stress-strain response of this alloy over a wide range of temperatures and in a form consistent with the constitutive equations presently recommended for use in inelastic design analysis of stainless steel nuclear components. The reported results form part of the data base being used by ORNL in formulating similar general inelastic constitutive equations for analysis of 2¼ Cr-1 Mo steel components.

32819 Elevated temperature fatigue and creep-fatigue properties of annealed 2¼Cr—1Mo steel. Ellis, J.R. (General Atomic Co., San Diego, CA); Jakub, M.T.; Jaske, C.E.; Utah, D.A. pp 213-246 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

This paper reports the results of a fatigue and creep-fatigue investigation conducted on 2¼ Cr-1 Mo steel, using test temperatures in the range of 800°F to 1100°F (427°C to 593°C). Results of preliminary characterization tests on three heats of annealed material revealed no significant differences in tensile or fatigue behavior, allowing the bulk of tests to be performed on a single master heat. Fatigue data are reported for the master heat, subjected either to isothermal anneal or to anneal by continuous slow cooling. No differences were observed for the two material conditions in regard to strain range versus cyclic life relationships. This was not the case for cyclic stress-strain response as the isothermally annealed material showed some evidence of metallurgical changes occurring during the testing. In cyclic relaxation tests with hold-periods of 5 to 60 minutes, the slow cooling anneal gave marginally better cyclic life compared to the isothermal anneal. In both materials, compression hold-periods resulted in reductions in cyclic life although not as much as with tension hold-periods. Finally, the hold-period data were used to evaluate the fractional damage and the strain-range partitioning method of creep-fatigue damage analysis.

32820 Thermal ratchetting studies of type 304 stainless steel: an evaluation of a new test procedure. Conway, J.B. (Mar-Test, Inc., Cincinnati); Berling, J.T.; Stentz, R.H.; Pugh, C.E.; Anderson, W.F. pp 247-281 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

A new test procedure was developed to enable certain aspects of high temperature thermal ratchetting to be evaluated. This experimental approach involves the use of two servo-controlled, hydraulically actuated low-cycle fatigue machines operating in unison and employs two specimens to provide an exact simulation of the two-bar (sometimes called three-bar) assembly which serves as a thermal ratchetting model. In this PVRC-sponsored program, three tests of 304 stainless steel specimens were performed using peak test temperatures of 593° and 649°C (1100° and 1200°F) along with cyclic temperature changes of 111° and 222°C (200° and 400°F). Initial loads were adjusted to provide stress levels of 36 percent and 72 percent of the 0.2 percent yield strength and hold period durations ranging from 5 minutes to 6 days were imposed. These conditions correspond to specially selected points within specific regimes of the Bree diagram. Measured values of the thermal ratchet strain per cycle are reported along with information relating to the cyclic stress-strain behavior that was noted in each test.

32821 Effects of sodium on the low-cycle fatigue behavior of austenitic stainless steel. Smith, D.L.; Natesan, K.; Kassner, T.F.; Zeman, G.J. (Argonne National Lab., IL). pp 290-301 of In Structural materials for service at elevated temperatures in nuclear power generation. Schaefer, A.O. (ed.). New York; American Society of Mechanical Engineers (1975).

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

See CONF-751106—.

Low-cycle fatigue data have been obtained on annealed Type 316 stainless steel specimens during exposure to well-characterized sodium. Instrumented sodium loops, in which the oxygen, carbon, and hydrogen concentrations in sodium are controlled and measured, provide the desired test environment. Two closed-loop servo-hydraulic testing machines have been used for the low-cycle fatigue tests, which have been conducted with axial stroke-control loading at a strain rate of approximately 4 x 10^{-3} sec^{-1}. The fatigue life of annealed Type 316 stainless steel tested in sodium is substantially greater than that tested in air. The fatigue life of sodium-exposed stainless steel (1512 hr at 600°C) that resulted in surface carburization of the material has also been investigated. The applied stress range for the sodium-exposed specimens decreased by 15-20 percent relative to the annealed specimens. For total strain ranges below approximately 1 percent, the fatigue life was enhanced by the 1500-hr sodium exposure.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 32385, 32388, 32857, 32973, 33430

32822 Fatigue strength of welded tubular joints in offshore structures. Teramoto, S.; Kawasaki, T.; Kaminokado, S.; Matoba, M. Hiroshima; Mitsubishi Heavy Industry (1975). 18p.

A study was made of the fatigue strength of tubular joints used for column stabilized drilling units or offshore drilling platforms. Fundamental guidelines and data are provided for designers engaged in this field by discussing the fatigue strength of such joints under complicated stresses and the most effective type of joint. Static and fatigue tests were carried out with regard to the essential factors of structural design by using 22 typical scaled-down models consisting of 8 different types of tubular joint in each of which the brace directly intersects the chord. The diaphragm-reinforced type of tubular joint is found to be more effective than the ring stiffener reinforced type for the prevention of fatigue crack intiation and the reduction of crack propagation. The right-angle type has higher resistance to fatigue crack initiation than the oblique-angle type. A considerably good correlation was obtained between the fully reversed strain-controlled fatigue test results on the basic specimens and the displacement controlled fatigue test results on the scaled-down models.

32823 Single-crystal elastic constants of a plutonium—gallium alloy. Moment, R.L. (Rockwell International, Golden, CO). pp 687-696 of In Plutonium and other actinides. Blank, H. (ed.). Amsterdam; North-Holland Publishing Co. (1976).

The single-crystal elastic constants of a plutonium-1 wt percent gallium alloy were determined at room temperature by measuring ultrasonic sound-wave velocities. The three independent elastic constants of this face-centered-cubic delta-phase alloy were determined from the longitudinal and the two shear-wave velocities, all along a (110) direction. Their values are C_{11} = 3.628, C_{12} = 2.673 and C_{44} = 3.359 in units of 10^{10} N/m^2; the respective errors are estimated to be 1, 1, and 0.3 percent. The Zener anisotropy ratio is 7:03, almost twice that known for any other fcc metal, and falls among the ratios for the body-centered cubic alkali metals, which are noted for their high elastic anisotropy. Polycrystalline elastic constants calculated from the single-crystal data are: Young's modulus E = 4.064, the shear modulus G = 1.596 and the bulk modulus (reciprocal compressibility) B = 2.991, all in units of 10^{10} N/m^2, and Poisson's ratio ν = 0.27. These values of E and G are both lower than those obtained by Taylor, Linford and Dean from measurements on polycrystalline specimens. Within a single crystal, the longitudinal sound velocity varies with direction by a factor of 1.4, and the transverse velocity by a factor of 2.6. The maximum Young's modulus (along [111]) was 5.4 times larger than the minimum (along [100]). The Debye temperature was calculated to be 105.7°K at 293°K and estimated to be 114°K at 0°K.

32824 Stress induced degradation of critical currents in filamentary Nb_3Sn. McDougall, I.L. (Imperial Metal Industries, Birmingham, Eng.). pp 396-399 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976).

See CONF-760508—.

An investigation of the critical stress and strain values of bronze Nb_3Sn composites at 4.2 K has been made with simultaneous determination of critical currents in a field of 2.5 Tesla. Evidence of grain boundary microcrack formation has been found associated with reversible degradation of critical current. At a critical strain characteristic of the composite geometry these cracks propagate to give a GB fracture network. Compound with a small grain size formed at low temperatures has the best mechanical properties with a critical strain to the onset of reversible degradation of about 0.5 percent.

32825 Interaction between the crystal lattice and vortices in thin films of type I superconductors. Rodewald, W. (Technische Univ.,

Berlin). pp 400-403 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

In thin Pb-films the correlation between the vortex lattice and the crystal lattice and the interaction of single vortices with crystal imperfections was investigated. The transition from the two-dimensional mixed state to the intermediate state could be observed directly on Pb-crystals of non-uniform thickness. In a perpendicular magnetic field of 240 A/cm the critical thickness for the existence of single vortices amounts to d/sub c1/ = 220 nm and for the formation of lamellae to d/sub c2/ = 280 nm.

32826 Superconductive transition temperatures of some solders. Meijer, H.C.; Bots, G.J.C.; Coops, G.M. (Technische Hogeschool, Delft, Netherlands). pp 404-405 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The superconductive transition temperatures of 13 soldering materials, which varied from very "soft" to "hard," at temperatures between 57 mK and about 15 K were studied. Seven of the solders investigated, all of them with a considerable amount of lead, showed within the accuracy of the measurement the same critical temperature of 7.1 K which is very close to the superconductive temperature of lead. The two hard solders showed no superconductivity down to 57 mK.

32827 Dilute aluminum alloys: their potential in superconducting devices. Hartwig, K.T.; Worzala, F.J. (Univ. of Wisconsin, Madison). pp 406-410 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Until an inexpensive, lightweight, high strength, low resistivity stabilizing material is developed, the full potentialities of large superconductive devices will not be realized. Copper has been used for essentially all applications of superconducting composite cable to date, but the cost of copper and its availability foreshadow problems for the future. The use of aluminium as a replacement for copper would solve both the cost and the materials shortage problems, if a high strength aluminium alloy could be developed—provided the alloy had a resistance ratio (rho/sub 273 K//rho sub 4.2 K/) equivalent to that of OFHC copper. An assessment of the possibilities of developing such an alloy is presented. The factors which influence yield strength and resistivity are outlined and a series of experiments are described. These experiments, conducted on dilute aluminium—gold alloys describe the process by which optimization of strength and resistivity can be achieved.

32828 Structure and superconducting properties of sputtered Nb_3Ge films. Braun, H. (Univ., Giessen, Ger.); Saur, E. pp 411-413 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Nb_3Ge films with thicknesses between 0.1 and 1.5 μm have been deposited on sapphire substrates by dc sputtering in a pure argon atmosphere. The maximum observed superconducting onset temperature T/sub c/ is 22.7 K. Investigations with a scanning electron microscope show that the crystallites exhibit columnar growth normal to the substrate. Critical current densities and upper critical magnetic fields have been measured as functions of magnetic field orientation and temperature.

32829 Surface effects on ac losses in superconducting niobium. Al-Huseini, F.A. (Univ. of Petroleum and Mineralogy, Dhahran, Saudi Arabia). pp 438-441 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Power losses at 50 Hz are measured (T = 4.2 K) in cylindrical rods of niobium (single crystal and polycrystalline Nb) as a function of peak applied magnetic field H/sub m/ below and above H/sub c1/, on samples with different surface treatments, using Wattmeter technique. The minimum power which could be observed by our experimental measurements is about 10^{-9}W/cm^3/cycle. The results show that losses below H/sub c1/ both single crystal (H/sub c1/ for the smooth surface 1550 gauss) and polycrystalline Nb decreases with smooth surfaces. These confirm the loss mechanism that surface roughness and impurities are the main factors in governing AC losses. When the applied magnetic field in the range H/sub c2/ greater than H/sub m/ greater than H/sub c1/ magnetic flux penetrates the sample to a depth, our results show that ac losses are still ruled by the surface state. This does not contradict with those calculated using the critical state model, where the measured J/sub c/ (using the same technique as Linford et al.) in our experiments is a dynamic quantity related to the surface conditions and not of the nature of the transport current. The results are in agreement with other workers' results that to achieve a minimum loss it is of primary importance to use materials with smooth surfaces.

32830 Hysteresis of niobium in time dependent fields up to 3 kOe amplitude. van de Klundert, L.J.M.; Nijnuis, H.T.; van de Braak, H.P.; van der Marel, L.C. (Twente Univ. of Tech., Enschede, Netherlands). pp 442-444 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The only model used so far for the description of the quasi static irreversible magnetic behavior of superconductors is the critical state model (CSM). In some cases values of the critical current density J/sub c/ are derived. Under special conditions even the position dependence of J/sub c/ due to inhomogeneous distributed pinning sites may be obtained. The usefulness of the CSM in these and other measurements is reinvestigated, especially for rather weak pinning in varying fields up to 25 x 10^4 A/m (3 kOe) amplitude. It was shown previously that applied fields of a trapezoidal waveform are advantageous because the contributions to the induced signal of the various CSM parameters are separated in time and may allow in special cases to determine these parameters quantitatively.

32831 High-frequency pair-splitting current in narrow superconducting films. Dmitriev, V.M.; Churilov, G.E. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **2**: No. 9, 596-597(Sep 1976).

The relation between the critical dc current in thin narrow tin films and the power of shf radiation within the X-band near the critical temperature T/sub c/ was studied experimentally. The critical high-frequency power has been determined here, as a function of the temperature and of the mean-free-path of electrons. It has also been shown that these relations agree closely with theoretical results based on an analysis of the Ginzberg-Landau pair-splitting mechanism. It has been confirmed experimentally, furthermore, that in an alternating field of intensity E/sub c/ an electron pair acquires, after having transversed the coherence path zeta (T), an energy equal to its binding energy.

32832 Photoemission from CO on Pt(111) using synchrotron radiation in the range 40 eV $<=$ h/2$\pi\omega$ $<=$ 150 eV. Apai, G.; Wehner, P.S.; Stoehr, J.; Williams, R.S.; Shirley, D.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Solid State Commun.;* **20**: No. 12, 1141-1145(Dec 1976).

Photoelectron spectra for CO adsorbed on the (111)-face of Pt have been measured using synchrotron radiation of energy 40 eV $<=$ h2$\pi\omega$ $<=$ 150 eV. A dramatic increase of the molecular orbital (MO) intensity relative to the intensity of the Pt 5d valence band (VB) is observed for h2$\pi\omega$ < 100 eV, to a ratio at h2$\pi\omega$ = 150 eV that is a factor of three higher than at H2$\pi\omega$ = 40 eV. The energy variation of the Pt 5d VB photoemission peak intensity has been derived independently in the 40-200 eV range from measurements on clean Pt. The 5d peak intensity is found to decrease steeply (by more than an order of magnitude) between 100 and 150 eV. The observed increase of the MO peak intensity relative to that of the 5d VB is attributed to this cross-section effect. The Pt VB peak nearest the Fermi energy which is mainly tsub(2g) in character, is found to decrease in intensity on adsorption of CO. In the present case synchrotron radiation in the h2$\pi\omega$<100 eV range appears to be especially valuable for studies of adsorbants.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 32181, 32386, 32519, 32526, 32632, 32839, 32900, 32904, 32921

32833 (AERE-R—7386(Rev)) Studies relevant to the reactions of gaseous impurities with circuit materials in helium cooled reactors. Warburton, J.B.; Antill, J.E.; Peakall, K.A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Aug 1976. 31p. NTIS (US Sales Only).

Available from H.M. Stationery Office, price Pound1.50.

The reactions of water vapour, carbon monoxide and methane with a range of iron and nickel base alloys have been studied with the alloys in the cold worked condition within the temperature range 400 to 800°C. A 1 to 15 μatm H_2O, 400 μatm H_2 environment decarburised a mild steel and to a lesser extent a 1.5Cr—1Mo steel at 400 to 500°C. The low-alloy steel was also oxidised slightly by the environment. The mild steel at 400°C and the low alloy steel at

500°C did not interact with <= 5500 μatm CH_4, but did catalyse carbon deposition from low partial pressures of carbon monoxide. The majority of the work was concerned with highly alloyed materials at 700 to 800°C. Their behaviour in complex environments containing 1 to 5 μatm H_2O and 100 to 400 μatm CO or 100 μatm CH_4 was generally dominated by oxidation by the water vapour. In the complete absence of water vapour the extent of reaction with carbon monoxide was almost independent of carbon monoxide pressure down to 500 μatm and then decreased only slightly down to 10 to 30 μatm. Carburisation by methane was approximately proportional to methane pressure and time of exposure. The presence of water vapour and of oxide films generally inhibited carburisation by both carbon monoxide and methane. The resistance of Incoloy 800, Sandvik 12R72HV and Nimonic 80A to oxidation by water vapour was poor by comparison with that for 316 steel, Esshete 1250 and Hastelloy X. However Hastelloy X and 316 steel together with Sandvik 12R72HV were on occasions susceptible to appreciable reaction with carbon monoxide. The high nickel alloys Hastelloy X, Nimonic 80A and to a lesser extent Incoloy 800 were carburised by methane more readily than 316 steel. Complex behaviour was observed in crevices in environments containing carbon monoxide or methane. It is attributed in part to the influence of water vapour.

32834 (NTIS/PS—76/1046) **Stress corrosion of steel (a bibliography with abstracts). Report for 1964—Nov 1976.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Dec 1976. 174p. NTIS.

Supersedes NTIS/PS—75/785.

The citations cover crack propagation, fracture, tests, surface finishing, working, coatings, deformation and fatigue in relation to stress corrosion. The majority of studies of this report are on nuclear reactor or spacecraft materials. Stainless steel stress corrosion is excluded. (This updated bibliography contains 169 abstracts, 44 of which are new entries to the previous edition.) (GRA)

32835 (PNC-N—941-75-61) **Mass transfer of 2.25Cr-1Mo steel for FBR in high temperature flowing sodium.** Aoki, N.; Ishii, T.; Maruyama, A.; Kawai, M.; Owada, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jun 1975. 87p. (In Japanese). NTIS (US Sales Only).

To study the corrosion behavior of the 2 1/4Cr—1Mo steel used for the tube of steam generator of FBR, the tests were planned up to 10,000 hours. This test was carried out for 5,000 hours. Maximum sodium temperature was 600°C, minimum sodium temperature was 380°C at the test section of the test loop, cold trap temperature was at 190°C. Results were as follows: 1) Corrosion rate at 600°C was 4.0 μ/year. 2) Corrosion rate increased with duration at 1,000 hours and 2,500 hours, but did not increase from 2,500 hours to 5,000 hours. 3) In this test, decarburization of 2 1/4Cr—1Mo steel depended on sodium temperature, and the rate-determining step was the diffusion of the carbon in the steel.

32836 Corrosion-erosion behavior of materials in a coal-gasification environment. Natesan, K. (Argonne National Lab., IL). *Corrosion;* **32**: No. 9, 364-370(Sep 1976).

Materials considered for application in the high temperature gaseous environments that are present in various coal-gasification processes must be resistant to corrosive and erosive wear. Possible interactions between the materials and the gaseous environment that lead to oxidation, hot corrosion, sulfidation, carburization, and metal dusting are discussed. Existing formalisms for predicting erosive wear loss of materials are presented. The need for additional research on corrosion of materials in complex multicomponent gas environments and on erosion of materials in the relevant range of process conditions to develop suitable models for corrosion-erosion behavior of materials is discussed.

32837 Effect of oxygen on hydrogen transport in copper. Caskey, G.R. Jr.; Dexter, A.H.; Holzworth, M.L.; Louthan, M.R. Jr.; Derrick, R.G. (Savannah River Lab., Aiken, SC). *Corrosion;* **32**: No. 9, 370-374(Sep 1976).

Hydrogen interaction with oxygen in copper exerts a significant influence on the apparent hydrogen diffusivity and the quantity of hydrogen absorbed. This interaction associated with steam embrittlement has been well established in alloys with high oxygen contents, such as electrolytic tough pitch (ETP) copper. However, the importance of this interaction on hydrogen transport in 99.999%, oxygen-free high conductivity (OFHC) copper and boron-deoxidized (BD) copper, apparently has not been recognized. Correlation of the amount of absorbed tritium with oxygen content and dependence of permeation transients on both oxygen content and prior treatment indicate that both reversible and irreversible interactions occur between hydrogen and dissolved oxygen.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 32667, 32817

32838 (BLG—509) **Use of staining metallographic reagents in the optical analysis as contribution to the microscopical study of irradiated austenitic canning materials.** Heylen-Geladi, M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Sep 1975. 8p. NTIS (US Sales Only).

10 figs. with 20 micrographs.

Investigation by interference film microscopy is rather difficult to realize in post-irradiation studies because of the lack of suitable facilities. To enable comparison to be made between structural compounds of unirradiated and irradiated samples, tests on staining metallographic reagents were performed and the results were compared with those obtained by interference film microscopy. Two solutions are particularly indicated to fulfill the condition of reliability for these canning materials; one is based on the reduction of selenic acid to selenium, the other, on the decomposition of a metabisulfite in an acid medium.

32839 Increase in corrosion resistance due to ion bombardment of metals. Khirnyi, Y.M.; Kochemasova, L.N. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 199-200(Jun 1976).

Stainless steel was bombarded with 65-keV ion beams. Using the method of secondary ion-ion emission, an increase in the corrosion resistance was observed. (AIP)

32840 Distributions of point defects in bounded media under irradiation. Yoo, M.H.; Mansur, L.K. (Oak Ridge National Lab., Tenn. (USA)). *J. Nucl. Mater.;* **62**: No. 2-3, 282-292(Nov 1976).

The steady state diffusion profiles of vacancies and interstitials in the half-space and the foil under irradiation at elevated temperatures are calculated by solving the general rate equations. The calculations include spatial variation of defect production and of size and number distributions of internal sinks, preferential absorption of point defects at internal sinks, thermal equilibrium vacancies, and the image interaction of point defects with free surfaces. Numerical calculations are made for Ni in the temperature range 0.3 T/ sub m/ to 0.5 T/sub m/, and applications to defect cluster formation during irradiation by heavy ions in an accelerator and by electrons in a high-voltage electron microscope are discussed.

32841 Radiation defects in gold-doped germanium. Golubev, N.F.; Latyshev, A.V. (Scientific-Research Institute of Applied Physics Problems at the V. I. Lenin Belorussian State University, Minsk). *Sov. Phys. - Semicond. (Engl. Transl.);* **10**: No. 12, 1385-1388(Dec 1976).

An investigation was made of the electrical properties of n- and p-type Ge crystals (GESZ-2.5, GDZ-0.6, GES-2.9) irradiated at T< or =320 degreeK with ^{60}Co γ rays and with 12 MeV electrons. The rates of removal of electrons from n-type samples and the rates of introduction of holes into p-type materials were determined at 100 and 300 degreeK. An analysis of the temperature dependences of the Hall coefficient of irradiated and annealed samples demonstrated that gold (Au) in n- and p-type Ge was an effective sink for primary radiation defects and formed complexes with these defects, which were stable up to 670 degreeK. The initial values of the carrier density and of the concentration of electrically active gold atoms (with levels at E/sub c/: 0.20 and E/sub v/+0.15 eV) were restored by annealing at 690—750 degreeK; the activation energy of the annealing of radiation defects at this stage was 2.4 eV for both types of material. Irradiation of Ge:Au produced two different complexes containing Au atoms. In the n-type Ge:Au both types of defect were acceptors, whereas in the p-type Ge:Au one of the defects was in an electrically neutral state and the other exhibited acceptor properties. One of the energy levels of the complexes containing Au was located near the middle of the forbidden band of Ge.

32842 Irradiation disordering of Ni_3Mn by replacement collision sequences. Kirk, M.A.; Blewitt, T.H.; Scott, T.L. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **15**: No. 6, 2914-2922(15 Mar 1977).

Replacement collision sequences have been investigated. Decreases in saturation magnetization were measured as a function of increasing neutron fluence in samples with different degrees of long-range order. These magnetic changes are related, through a unique dependence on sample order, to the production of < 110 < replacement collision sequences by irradiation. This dependence has been determined by computer model calculation. The results of four irradiations on samples of different degrees of long-range order yield an average of 132 +- 10 replacements in < 110 < sequences per 450 eV (n,γ) recoil. Arguments are presented which suggest these 132 replacements are produced in one or two long sequences rather than in many short sequences. These results are compared with previous experiments and computer calculations on replacement collision sequences.

32843 Anisotropic momentum densities from Compton profiles: Silicon. Mueller, F.M. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **15**: No. 6, 3039-3044(15 Mar 1977).

A new inversion procedure, based on Fourier analysis, is developed. Application is made to the silicon data of W. A. Reed and P. Eisenberger. The important experimental question of the relation between the number of sets of profiles, data lines, and the

accuracy of the inverted momentum density is answered in detail. The inversion procedure may also be applied to a related problem in positron annihilation.

32844 Changes in the superconducting critical temperature after fast-neutron irradiation. Brown, B.S.; Hafstrom, J.W.; Klippert, T.E. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **48**: No. 4, 1759-1762(Apr 1977).

The decrease in the superconducting transition temperature T/sub c/ after fast-neutron irradiation has been measured in V_2Hf (C-15 Laves phase), Nb_3Al (A-15 phase), $PbMo_6S_7$ (Chevrel phase), and $SnMo_6S_8$ (Chevrel phase). The samples were irradiated at 6 K and warmed to 300 K during transfer to the measuring cryostat. The T/sub c/ of the samples was measured as a function of dose up to 3.0 x 10^{19} n/cm^2 (E<0.1 MeV). The different crystal structures showed a marked difference in the sensitivity of the T/sub c/ depression with irradiation. The total decrease in T/sub c/ of V_2Hf was 5%, while $\Delta T/sub\ c/(Nb_3Al) = 23\%$, $\Delta T/sub\ c/(PbMo_6S_7) = 61\%$, and $\Delta T/sub\ c/(SnMo_6S_8) = 51\%$. Log($\Delta T/sub\ c/$) was linear with dose for all samples as expected for radiation saturation, i.e., the damage rate was proportional to the undamaged fraction. The recovery of T/sub c/ after a series of 5-min isochronal anneals up to 1200 degreeC has been measured, and the annealing stages observed are discussed in terms of the radiation-induced defects.

32845 Defect production in copper and silver by light energetic ions. Averback, R.S.; Benedek, R.; Merkle, K.L. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Appl. Phys. Lett.;* **30**: No. 9, 455-457(1 May 1977).

Measurements have been made of the change in residual electrical resistivity in thin-film specimens of Cu and Ag induced by light-ion irradiations (H,D,^{3}He, ^{4}He) below 10 K in the energy range 15—40 keV. The number of Frenkel pairs created per incident ion was deduced and compared with theoretical predictions. The efficiency factor (ratio of experimental to theoretical value) was found to decrease from ~1 to 0.7 (0.9 to 0.65) for Cu (Ag) as the recoil spectrum was shifted to higher energies by increasing the projectile mass and/or energy.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 32079, 32100, 32103, 32543, 32667, 32803

32846 Production of V_2O_5 crystals with a low dislocation density. Volzhenskii, D.S.; Grin', V.A.; Savitskii, V.G. (L'vov State University). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **21**: No. 6, 718-719(Nov 1976).

Thin transpararant single crystal plates of Vanadium pentoxide with low dislocation density have been grown by vapor-phase transport. (AIP)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 32849, 32850

32847 (MLM—2400) **Program for calculating x-ray powder diffraction interplanar (d) spacings with a Tektronix-31 desk top programmable calculator.** Eckstein, R.R.; Ishida, Y.G. (Mound Lab., Miamisburg, Ohio (USA)). 22 Feb 1977. Contract EY-76-C-04-0053. 16p. Dep. NTIS $3.50.

A Tektronix-31 (Tektronix Inc. Beaverton, Oregon) desk top calculator program, which is used as a backup to the PDP-8/I computer program, is described. The program yields interplanar (d) spacings and (2theta) angle values from measurements made on an x-ray diffraction film of a powdered sample of a crystalline material. Use of the calculator provides accurate computations in a relatively rapid time interval when the PDP-8/I is not functioning because of downtime for repairs, maintenance, etc.

32848 Thermal expansion and phase transformations of the $U_3O_{sub}(8-z)$ phase in air. Ackermann, R.J.; Chang, A.T. (Argonne National Lab., Ill. (USA)); Sorrell, C.A. *J. Inorg. Nucl. Chem.;* **39**: No. 1, 75-85(1977).

Detailed thermal expansion data have been obtained by high temperature X-ray diffractometry of U_3O_8 and $U_3O_{sub}(8-z)$ in air between 22 and 1100°C. Stoichiometric U_3O_8 changes continuously, reversibly and anisotropically above room temperature with expansion along the a-axis and contraction along the b-axis from orthorhombic to hexagonal symmetry at 350 +- 10°C. A small but continuous contraction along the c-axis occurs up to 1100°C. Both parameters of the hexagonal phase expand smoothly and reversibly to approximately 875°C and exhibit no discontinuity as a result of loss of oxygen which begins near 600°C. At 875 to 925°C the structure changes to lower symmetry by contraction along the a-axis and expansion along the b-axis. This structural change is accompanied by a more extensive loss of oxygen and is usually irreversible unless the crystallite size is sufficiently small, approximately 0.05 μm for which both the compositional and structural changes are reversible with temperature. Calculated unit cell volumes undergo slight expansion and contraction up to 350°C, with a broad maximum at approximately 200°C and a smooth expansion at a decreasing rate from 350 to 875°C. The irreversible transition beginning at 875°C is ostensibly associated with an expansion-contraction anomaly in the temperature range 875 to 925°C, followed by smooth expansion at a decreasing rate to 1100°C. The thermal expansion characteristics have been interpreted in terms of rotation of octahedral linkages in the orthorhombic and hexagonal structures and the irreversible transition has been tentatively explained in terms of two $U_3O_{sub}(8-z)$ phases, one orthorhombic and one monoclinic. The apparently contradictory structural analyses for the U_3O_8 and $U_3O_{sub}(8-z)$ phases in the literature can be reconciled on the basis of the thermal expansion results which involve both changes in temperature and composition.

PHYSICAL PROPERTIES

32849 (JAERI-M—6180) **Phase relations, crystal structures and physical properties of nuclear fuels.** Tagawa, H.; Fujino, T.; Tateno, J. (Japan Atomic Energy Research Inst., Tokyo). Jul 1975. 79p. (In Japanese). TIC.

384 refs.

Phase relations, crystal structures and physical properties of the compounds for nuclear fuels are presented, including melting point, thermal expansion, diffusion and magnetic and electric properties. Emphasis is on oxides, carbides and nitrides of thorium, uranium and plutonium.

32850 Influence of the metal-semiconductor phase transition in vanadium dioxide on the transmission and reflection of electromagnetic waves. Bilenko, D.I.; Zharkova, E.A.; Ryabova, L.A.; Serbinov, I.A.; Khasina, E.I. (Scientific-Research Institute of Mechanics and Physics, Saratov State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 7, 250-251(Jul 1976).

The transmission, reflection, and reflected wave phase have been measured for VO_2 films on dielectric substrates. Microwave radiation of wavelengths between 0.8 and 8 mm was studied in the temperature range 25—75degree.

32851 X-ray photoelectron-spectroscopy study of oxides of the transuranium elements Np, Pu, Am, Cm, Bk, and Cf . Veal, B.W.; Lam, D.J.; Diamond, H.; Hoekstra, H.R. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **15**: No. 6, 2929-2942(15 Mar 1977).

Systematic x-ray photoelectron spectroscopy (XPS) measurements are reported for both core and valence electrons for oxides of the actinides thorium, uranium, neptunium, plutonium, americum, curium, berkelium, and californium. The XPS spectra of the localized 5f electron states were compared to the appropriate multiplet calculations for the neutral atom. Agreement between theory and experiment was generally good but substantial solid-state broadening of the oxide spectra limited the capability for comparing detailed spectral features. Binding energies of several prominent core lines are systematically presented as a function of atomic number for the series of actinide oxides. Comparisons are made between the measured energies and the corresponding calculated energies reported by other investigators. Anomalous core-level spectra (most notably the 5d's), which probably result from coupling of the hole-state magnetic moment with the moment of the unfilled 5f shell, are presented.

32852 First-order induced Raman scattering from Ni^{2+} ions and cation vacancies in LiCl. Bates, J.B.; Wood, R.F.; Shankle, G.E.; Mostoller, M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **15**: No. 6, 3267-3272(15 Mar 1977).

First-order induced Raman scattering has been observed from single crystals of LiCl containing Ni^{2+} ions. Sharp bands at 247, 216, 161, and 122 cm^{-1} are assigned to $A_1/sub\ g/$, $T_2/sub\ g/$, $E/sub\ g/$, and $T_2/sub\ g/$ modes, respectively, on the basis of polarization measurements with < 100 < and <110 < crystals. No differences were observed in the experimental peak positions, bandwidths, or relative intensities for crystals in which the Ni^{2+} concentration differed by a factor of 2. Theoretical calculations suggest that the $A_1/sub\ g/$ and the higher frequency $T_2/sub\ g/$ bands are due to vibrations about the Ni^{2+} ions, while the $E/sub\ g/$ and possibly the lower-frequency $T_2/sub\ g/$ bands can be assigned to the local modes about the cation vacancies.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 31766

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 32102

32853 Sensitivity of zinc oxide surface to bombardment by low-energy inert-gas ions. Koshcheev, A.P.; Panesh, A.M.; Myasnikov, I.A. (L. Ya. Karpov Scientific-Research Physicochemical Institute). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 7, 238-239(Jul 1976).

Zinc oxide films were bombarded with 100 eV ions and the resulting change in the electric conductivity was observed. (AIP)

32854 The spectral reflectivity of ion-bombarded surfaces. Primak, W. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **48**: No. 4, 1556-1562(Apr 1977).

A variety of effects are found to contribute to changes in spectral reflectivity found after bombardment with ions of gaseous species; they cannot be assigned solely to the formation of a gas layer. There may be a change in refractive index and thickness associated with a phase change (e.g., quartz); a decrease in refractive index and an increase of thickness by the introduction of microporosity (e.g., SiC, B_4C, Al_2O_3); an increase in refractive index from the introduction of centers, etc. (e.g., SiC, MgO); an increase of refractive index and a decrease in thickness by compaction (e.g., vitreous silica); or a decrease in refractive index caused by changes in composition (e.g., alkali loss in glasses). Often the chromatic fringes are composites of different fringe systems arising in different parts of the illuminated area; and within any part of an area, there may be more than one cause. These effects are observed in the early stages of bombardment manifested by changes in spacing, phase, amplitude, and level of the chromatic fringes. When a gas layer forms (blistering) the large amplitude of the chromatic fringes associated with it usually dominates the spectral reflectivity at large dose, but this is not always the case (e.g., C1 glass).

COMPOSITE MATERIALS

REFER ALSO TO CITATION(S) 32770

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 32803

MECHANICAL PROPERTIES

32855 Flexible multifilamentary compound superconductor. Tanaka, Y.; Furuto, Y.; Ikeda, M.; Inoue, I.; Tanii, J. (Furukawa Electric Co., Ltd., Tokyo). pp 381-384 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Five types of cables, that is, a stranded wire, a parallel-assembled stranded cable, a stranded-braided cable, multifilamentary tape and a compacted-stranded cable, were manufactured and put into the evaluation of the flexibility, the current capacity, the current anisotropy and the coil characteristics. The test results indicate that the multifilamentary tape and the compacted-stranded cable are free from the current anisotropy and stable.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 32964, 33432

32856 Thermal conductivity and diffusivity of glass-fibre epoxy resin composites between 2 K and 15 K. Mazzarello, F.; Michi, U.; Siri, A.; Spriano, A.; Vaccarone, R. (Istituto di Scienze Fisiche, Genoa). pp 362-366 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A standard technique which has developed in the last few years for the construction of superconducting windings is that of vacuum impregnating the winding with epoxy resins. To achieve reproducible results on thermal cycling, and to avoid transitions due to the release of mechanical energy by cracks induced in the resin, as well as to increase the overall strength, the epoxy resin must be filled with glass fibers. Technologically, it is interesting to know the variation of the various properties of the epoxies with the amount of filling and orientation of fibers. The relevant parameters in this respect are the overall thermal conductivity, the thermal diffusivity and the specific heat, which are related together on a microscopic scale, but not necessarily on a macroscopic scale, if the material considered is inhomogeneous, and if there are boundaries (as for example between the epoxy and the glass or between copper walls and epoxy). Here, thermal conductivity measurements and preliminary thermal diffusivity results which have been obtained by using one single apparatus are reported.

32857 Procedure of continuous measurement of critical current and stability of superconducting tapes and composites. Rupp, G. (Siemens AG, Erlangen, Ger.). pp 385-386 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A procedure is described to measure continuously and without damage the local dependence of the critical current and the stability of superconducting tapes and composites. In the superconducting state the conductor is subjected to a change of an external magnetic field. The magnetic field of the induced screening current measured outside the conductor by Hall-probes is a measure of the critical current of the superconductor. In Nb_3Sn-tapes deposited from the vapor phase defects with reduced critical current and those with changed stability can be localized. The tapes can be tested before being wound into coils. The procedure applied to multifilamentary NbTi-wires allows localizing not only large damage like the breaking of filaments but also changes in the geometry of the cross-section and in the distribution of the filaments.

32858 Experimental measurement of the power increase at a current close to the critical current. Genevey, P. (CEN/Saclay, Gif-sur-Yvette, France). pp 445-448 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Loss and throughput measurements in the superconductors are usually done by calorimetric or electric methods. These techniques give only the averaged losses per cycle. The knowledge of the instantaneous power is important to know the temperature in a pulsed magnet. In a composite having multilayers of filaments the self field effect near the critical current gives extra losses and these losses can limit the characteristics of a coil. These extra losses have, to our knowledge, never been measured.

32859 External field effects on current distribution in multifilamentary composites. Fournet, G.; Boyer, L. (LGEP-LCIE, Fontenay-aux-Roses, France). pp 451-453 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The current distribution within a multifilamentary composite subjected simultaneously to its own transport current I and to an orthogonal external field B/sub e/ such as B/sub e/ = KI is studied. In the first part a critical analysis of previous papers (dealing with the same problem) is presented, whereas in the second part an analytic solution, valid for a specific situation, is given. The role played in the phenomenon by a number called the reduced coupling factor is pointed out.

32860 New technique for measuring ac losses in multifilament superconductors. Pech, T.; Fournet, G.; Domarco, G. (LGEP-LCIE, Fontenay-aux-Roses, France). pp 454-457 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A rather sensitive calorimeter has been constructed. By taking advantage of the difference in relative permittivities for liquid helium and for helium gas, the detection of the helium gas boiled off in the calorimeter, due to the losses of a composite sample, is achieved by means of a capacitance bridge. When discussing the design and calibration of the apparatus, the rather complex thermal phenomena related to its operation are particularly pointed out.

32861 Transverse electrical conductivity of superconducting multifilamentary composites. Davoust, M.E. (LGEP-LCIE, Fontenay-aux-Roses, France); Renard, J.C. pp 458-460 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Losses in superconducting multifilamentary composites subjected to time-varying magnetic fields, depend practically on their transverse electrical conductivity. This characteristic results from the nature and the arrangement of the components of the matrix, and from the quality of the interface between the composite components. A method of measuring transverse electrical conductivity by induced currents is given. This method involves measuring the electric field appearing when an axial magnetic field step is applied. The values of transverse electrical conductivity for different composites are given. In some cases, values are much lower than those expected from the conductivity of the individual components. This point is

discussed with the help of metallurgical investigations of the quality of the interface between composite components.

32862 Critical current degradation in high current NbTi composites subjected to time-dependent currents up to 10^4 A/s. Boyer, L. (LGEP-LCIE, Fontenay-aux-Roses, France); Renard, J.C. pp 464-466 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Certain theories have predicted that the use of high current multifilamentary composites, with large numbers of filaments, will be limited by self-field instabilities. In order to investigate this effect 'transition current' measurements were carried out on several multifilamentary composites, subjected to an external stationary induction B/sub e/, and submitted to a time-dependent current at rates of change up to 10^4 A/s. Composites used in these experiments had numbers of filaments close to 7×10^3, with one or two-component matrix (Cu or Cu—CuNi). Measurements showed that the critical current degradation was not markedly influenced by the characteristics of the composites but strongly depended on the heat exchange between the sample and the helium bath. When heat transfer was high, degradation occurred in the low induction region only (B/sub e/ less than 1.5 T) whereas in cases of poor heat transfer, degradation was large up to high inductions. This behavior is not due to self-field instabilities alone. Experimental results are compared with 'transition currents' calculated from a theory which takes account of losses appearing in the sample during the current rise-time.

32863 High B losses in multifilament superconducting wires. Wollan, J.J. (Los Alamos Scientific Lab., NM). pp 467-472 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Magnetic energy transfer and storage systems for prototype fusion reactors will have transfer times corresponding to B's as high as 3×10^7 G/s. To provide a basis for energy loss estimates and coil design, short sample loss measurements have been made on a set of copper matrix, Nb—Ti, multifilament superconducting wires. Both hysteretic and dynamic losses were measured for a field applied perpendicular to the wire axis. Losses were measured as a function of B, maximum applied field, wire diameter, matrix ratio, and conductor twist pitch. For low B's and low maximum applied fields, the losses increased monotonically. As B and the maximum applied field were increased, a peak occurred in the loss as a function of B.

POLYMERS AND PLASTICS

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 32923

32864 Dielectric properties of polymeric materials at low temperatures and high frequencies. Meyer, W. (Technische Univ., Brunswick). pp 367-371 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

As part of a DFG (Deutsche Forschungsgemeinschaft)-project concerning the development of a superconducting coaxial line for long distance communication similar to Japanese modes, the dielectric properties of many commercially available polymers were investigated from 0.1 to 10 GHz and 2.2 to 4.2 K. Because of great experimental difficulties, there are only a few dielectric measurements performed in this region. With a newly developed measuring method using superconducting helix and cavity resonators, the loss from 2.2 to 4.2 K and 0.1 to 10 GHz was found to be governed by tunneling relaxation and the low frequency tail of the IR-absorption. The best tan delta (2.2 K, 6.5 GHz) = 3.7×10^{-7} is one order of magnitude smaller than reported before on any solid material at any temperature and frequency (except the optical region).

32865 Dielectric losses in polyethylene and polypropylene. Gilchrist, J.leG. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). pp 372-375 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Terms contributing to the losses of these polymers are listed and pertinent data presented. Evaporated electrodes can cause conduction losses while some anti-oxidants cause relaxation losses in both materials and hydroperoxides resulting from oxidation cause relaxation loss in polyethylene only. The course of the polyethylene autoxidation reaction is followed with 4.2 K experiments.

32866 Optical properties of polystyrene from the near-infrared to the x-ray region and convergence of optical sum rules. Inagaki, T.; Arakawa, E.T.; Hamm, R.N.; Williams, M.W. (Department of Physics, Osaka Kyoiku University, Osaka, Japan). *Phys. Rev., B;* **15**: No. 6, 3243-3253(15 Mar 1977).

Optical properties of polystyrene in the form of thin films were determined for photon energies between 0.6 and 82 eV from transmission measurements. The results for k, the extinction coefficient, were combined with previous experimental results in the soft and hard x-ray regions up to 8050 eV. Analyses were made on several sum rules for the optical properties in this unusually wide energy range, including a sum rule for the refractive index n, derived recently by Altarelli et al. Redistribution of the oscillator strength corresponding to 2.7% of the total electrons was found between the valence and core excitations of carbon. Using the complex dielectric function and the energy-loss function obtained, the average photoexcitation energy and the average energy loss for fast-charged particles over the entire oscillator strength distribution were evaluated to be 25.1 and 36.8 eV, respectively.

OTHER MATERIALS

32867 (NTIS/PS—76/0687) Carbon and graphite. Part 3. Graphite—physical, mechanical and structural studies (a bibliography with abstracts). Report for 1964-Jun 76. Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 215p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/615, and NTIS/PS-75/181.

Research on the physical, mechanical, and structural properties of graphite are presented. Studies of graphite composites and fibers are excluded along with graphite chemistry. The majority of these studies deal with the use of graphite as a reactor material. (This updated bibliography contains 210 abstracts, 68 of which are new entries to the previous edition.) (GRA)

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 32099, 32803

32868 (IS-T—736) Synthesis and characterization of some reduced zirconium halides. Daake, R.L. (Ames Lab., Iowa (USA)). Feb 1977. Contract W-7405-ENG-82. 84p. Dep. NTIS $5.00.

Thesis.

High temperature equilibrium experiments have revealed several new zirconium subhalides as well as nonstoichiometry among the better-known trihalides. Product characterization by standard gravimetric and electron microprobe analyses was allied with x-ray powder and single crystal work. Accurate lattice parameters for phases of known cell type were determined from high precision x-ray powder data obtained by Guinier methods with Si powder as an internal standard. Up to 50 g batches of ZrCl and the hitherto unreported ZrBr have been prepared stoichiometrically from ZrX_4 and thin (3 to 4 mils) Zr turnings. Virtually 100% yields of <99.5% pure $ZrCl_3$ and $ZrBr_3$ were subsequently made by reacting well-ground mixtures of ZrX_4 with the very soft graphitic monohalides. Since ZrI does not exist, ZrI_3 was prepared from ZrI_4 and $ZrI_{1.8}$, the most reduced iodide phase. New compounds in the Zr—Cl and Zr—Br systems were prepared either by isopiestic equilibration of ZrX and ZrX_3 and/or via transport in a thermal gradient. A single crystal structure determination has shown the $ZrCl_{2.5}$ phase to be the first Group IVB M_6 cluster compound. It crystallizes in space group Ia3d with $Z = 16$ and is isostructural with Ta_6Cl_{15}.

32869 (NIIAR-P—239) Description of radiation damages to reactor graphite structures based on simularity criterion. Klimenkov, V.I. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1974. 12p. (In Russian). TIC.

13 refs.; 5 figs.

A method of expressing analytically radiation damages in graphite is developed on the basis of the similarity criterion of the irradiation conditions - the Kurchatov criterion Kv, which involves the temperature of irradiation and the neutron flux density. The formulated equations of the dose dependence and of the distribution of the qraphite radiation damages over the reactor masonry agree well with the experimental results.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 32799, 33364

32870 (ORNL-tr—4245) Porosity determination on pyrocarbon using automatic quantitative image analysis. Koizlik, K.; Uhlenbruck, U.; Delle, W.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H.

(Germany, F.R.)). May 1976. Translation by E.G. Silver of JUL—1294. 84p. Dep. NTIS $5.00.

Methods of porosity determination are reviewed and applied to the measurement of the porosity of pyrocarbon. Specifically, the mathematical basis of stereology and the procedures involved in quantitative image analysis are detailed. (SDF)

32871 Crystal structure of the double rubidium dysprosium tungstate, $RbDy(WO_4)_2$. Ipatova, E.N.; Klevtsova, R.F.; Solov'eva, L.P. (Institute of Inorganic Chemistry, Siberian Branch, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **21**: No. 6, 648-651(Nov 1976).

The crystal structure of monoclinic $RbDy(WO_4)_2$ (a=8.90, b=10.25, c=7.93 A, β=99degree, Z=4, Fedorov group C_2/sub h/^{5}=$P2_1/c$) is determined from three-dimensional diffraction data (Weissenberg x-ray goniometer, Mo radiation) and refined by the method of least squares to R=0.13 by reference to ~1700 E/sub h k l/. The principal part of the structure comprises discrete plane groups of four W polyhedra $[W_4O_{16}]^{8-}$. The great scatter in the W-O distances (1.68—2.59 A) allows the coordination of W to be taken as either 5 or 6. The Rb and Dy atoms lie within eight-pointed polyhedra which form wide double bands parallel to the [001]. The link between individual fragments in the structure is effected by virtue of common elements between the W octahedra and Dy polyhedra (common edges and face) and the Rb polyhedra (common vertices and edge).

PROPERTIES

REFER ALSO TO CITATION(S) 31760, 32505, 32832, 33344

32872 (AD—A029815) **Multiaxial creep in concrete. Final report.** McDonald, J.E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). May 1973. 30p. (WES-MP-C—73-6). NTIS (US Sales Only) $4.00.

The purpose of the investigation upon which this paper was based was to develop information regarding the time-dependent deformation (creep) behavior of concrete in the presence of varying temperature, moisture, and loading conditions similar to those encountered in a prestressed concrete reactor vessel (PCRV). This particular investigation was concerned with one concrete strength, three aggregate types, one cement, two moisture conditions, two testing temperatures, and four loading conditions. A comprehensive evaluation of the effects of these factors on the behavior of concrete as determined in this investigation has not been completed. However, some of the general conclusions from a limited preliminary evaluation are presented. (Author) (GRA)

32873 Concrete for PCRVs: strength of concrete under triaxial loading and creep at elevated temperatures. Linse, D.; Aschl, H.; Stoeckl, S. (Technische Univ. Muenchen (Germany, F.R.)). pp 1-13 of In Structural mechanics in reactor technology. Vol. III. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

To provide detailed information for the calculation of prestressed concrete reactor vessels, investigations of the behaviour of concrete under multiaxial loading and on creep at elevated temperatures were made at the Institut fuer Massivbau of the Technical University of Munich. The strength of concrete under triaxial compression is dependent on the stress ratio. The less the stresses differ from hydrostatic compression the more strength increases. Triaxial compression increases very much the deformability of concrete. Plastic deformations of +-10% and more (all stresses compression, but not equal, strains compression or tension) are possible without large cracks. The creep deformations are considerably dependent on the temperature. Creep at 80°C is about three to four times higher than at 20°C. The Poisson's ratio of creep at elevated temperature seems to be bigger than at normal temperatures at a rate of loading of 35% and 50% of the ultimate strength.

32874 Influence of multiaxial preloading on the strength of concrete. Linse, D. (Technische Univ. Muenchen (Germany, F.R.)). pp 1-9 of In Structural mechanics in reactor technology. Vol. III. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Concrete of PCRVs is normally loaded triaxially. During the lifetime of the reactor, stress changes of the concrete are possible. Most of the investigations about multiaxial stress-strain behaviour of concrete were made with short-term loading without looking at the history of preloading. To get some information about this important problem for the design of PCRVs tests on the influence of multiaxial preloading of concrete and of changing direction (which is a special type of multiaxial preloading) were done at the Institut fuer Massivbau of the Technical University of Munich. It was found that multiaxial preloading which is far below the ultimate multiaxial strength can considerably defect the remaining strength of concrete. Further tests are planned.

32875 Minimizing cold losses during transfer and storage of liquefied gases. Schrawer, R. (Messer Griesheim GmbH, Frankfurt am Main). pp 263-266 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Apart from using a high-quality insulation, cold losses of cryogenic fluids can be reduced by the utilization of thermodynamic models, based on recent results. These models involve the optimization of pipes in view of the dissipation energy of flowing fluids as well as the optimization of the general equations regarding the cooling effect of cryogenic vessels by refrigerated shields.

32876 Heat and mass transfer in multilayer insulations. Mikhal'chenko, R.S.; Pershin, N.P.; Sidorenko, I.G. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 298-302 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Presented are results of theoretical and experimental studies of heat and mass transfer in low temperature multilayer insulations during evacuation.

32877 Low temperature mechanical properties of insulating materials. Thoris, J.; Bobo, J.C. (Laboratoires de Marcoussis, France). pp 353-357 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The ability of synthetic insulating materials to withstand extreme temperature changes without any degradation of their mechanical properties has been the scope of several studies on the following topics: instantaneous failure before and after thermal aging and long date mechanical properties under static and dynamic fatigue. The evolution of static properties of some reinforced thermoplastic and thermosetting polymers was studied as a function of temperature (at 300 to 77 and 4.2 K) and of the direction of applied stress. Then the fatigue life-time curves of different materials were determined. The tests have been performed under tension, bending or compression.

32878 Helium migration in lithium aluminosilicate glasses. Shelby, J.E. (Sandia Laboratories, Livermore, California 94550). *J. Appl. Phys.;* **48**: No. 4, 1497-1502(Apr 1977).

Helium permeation, diffusion, and solubility have been measured for a number of lithium silicate and aluminosilicate glasses. Helium mobility in the lithium silicate glasses is controlled by the two-phase morphology of these glasses. Addition of as little as 2 mol% alumina strongly suppresses the tendency toward phase separation, i.e., yields homogeneous glasses. The compositional dependence of helium mobility in these glasses indicates that a major change in the glass structure occurs when the alumina-to-lithia ratio exceeds unity. Comparison of these results to those for analogous sodium aluminosilicates indicates that lithium has a greater effect than sodium on the free volume of the glass.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 32911, 33347

32879 Solubility of solid nitrogen tetroxide in liquid nitrogen. Szczepaniec-Cilciak, E.; Wojtaszek, Z. (Jagellonian Univ., Krakow). pp 278-280 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Tech. ology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The solubility of solid nitrogen tetroxide (N_2O_4) in liquid nitrogen (LN_2) at 77.4 K was studied using the filtration method. Solid N_2O_4 was found to be insoluble in LN_2 down to the value 10^{-10} mole fraction. The experimental results were compared with the solubility calculated on the basis of the Scatchard-Hildebrand equation.

32880 Spin polarization in the high-H/sub c/2 compound $Sn_{0.3}Eu_{0.3}Mo_6S_8$. Fradin, F.Y.; Shenoy, G.K.; Dunlap, B.D.; Aldred, A.T.; Kimball, C.W. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **38**: No. 13, 719-722(28 Mar 1977).

NMR studies of ^{95}Mo show that the enhancement of H/sub c/2 (~100 kG) in Eu-substituted $SnMo_6S_8$ arises from a negative s-

band spin polarization at the Mo site. Moessbauer-effect studies of ^{151}Eu indicate a small positive polarization at the Eu site and a weak Korringa relaxation, which is consistent with the weak depression of T/sub c/. The Eu^{2+} isomer shift (-14.0 mm/sec) shows an extremely low s-electron density at the rare-earth site.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 33101

32881 (CEA-N—1903) **Isostatically moulded graphite. Behavior under neutron irradiation.** Mottet, P.; Micaud, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie). Sep 1976. 22p. (In French). NTIS (US Sales Only).

An isotropic graphite has been studied. This fine grain graphite is obtained by isostatic moulding, so that it is quite isotropic in the three axes of the block. The CEA has used this material for irradiation experiments on HTR graphite and fuel. The isostatic graphite, as it is very isotropic, shows good dimensional stability under irradiation. After the examination of the physial and mechanical properties of this graphite, the variations of the thermal expansion, and thermal conductivity coefficients are presented. These variations are similar to those of the coefficients of classical nuclear graphite.

32882 (NTIS/PS—76/0763) **Ion implantation (a bibliography with abstracts). Report for 1964—Aug 76.** Reimherr, G.W. (National Technical Information Service, Springfield, Va. (USA)). Oct 1976. 207p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/661.

The cited reports discuss research concerning ion implantation, particularly as applied to the microelectronics field. Specific topics include equipment, techniques, semiconductor doping, and radiation effects on material properties. (This updated bibliography contains 202 abstracts, 61 of which are new entries to the previous edition.) (GRA)

32883 Radiation damage in silicon resulting from complete stopping of 30 MeV protons. Gorelkinskii, Y.V.; Sigle, V.O.; Botvin, V.A. (Institute of High-Energy Physics, Academy of Sciences of the Kazakh SSR, Alma-Ata). *Sov. Phys. - Semicond. (Engl. Transl.);* **10**: No. 12, 1339-1341(Dec 1976).

The ESR method was used in a study of radiation defects created in single-crystal silicon by 30 MeV protons. The distribution of the paramagnetic centers was determined as a function of the proton energy between 30 and ~10 MeV. It was established that in this range of energies the rates of introduction of centers with high (~10 keV) and low (~100 eV) threshold energies of formation were independent of the proton energy. The structure of the radiation damage was determined by investigating the ESR spectra of samples with high phosphorus concentrations ($\sim 10^{17}$-10^{18} cm^{-3}) after irradiation with various proton doses. For comparison, measurements were made also on silicon samples irradiated with fast reactor neutrons. The probabilities of formation of disordered regions by recoil nuclei of energies exceeding ~10 keV were approximately equal in the proton (30 MeV) and neutron irradiation cases. However, when silicon was bombarded with protons, about 80% of the divacancies (Si-G7 centers) formed were located outside the disordered regions.

32884 Influence of γ irradiation on electrical properties of chlorine-doped semiinsulating cadmium telluride crystals. Alekseenko, M.V.; Arkad'eva, E.N.; Matveev, O.A. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **10**: No. 12, 1409-1410(Dec 1976).

Irradiation of semiinsulating crystals with ^{60}CO γ rays (3 x 10^{16} cm^{-2} dose) generated mainly donors, which were not annealed significantly up to ~80 degreeC. The electron mobility in the irradiated crystals was low (~30-100 $cm^2xV^{-1}xsec^{-1}$) and, in contrast to unirradiated crystals, it rose rapidly with temperature.

32885 Energy dependence of the rate of degradation of the conductivity of silicon as a result of proton irradiation. Kozhevnikov, V.P.; Zhukov, Y.N. *Sov. Phys. - Semicond. (Engl. Transl.);* **10**: No. 12, 1414-1415(Dec 1976).

The rate of degradation of the electrical conductivity of silicon was determined as a function of the proton energy in the 2-60 MeV range. The results were compared with the published information on the rate of degradation on the minority-carrier lifetime in silicon.

32886 Aggregation and migration of ion-implanted silver in lithia-alumina-silica glass. Arnold, G.W.; Borders, J.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **48**: No. 4, 1488-1496(Apr 1977).

The near-surface nucleation and crystallization behavior of Ag^+ ion-implanted lithia-alumina-silica glasses has been studied. For room-temperature Ag implants, crystallization of the glass ceramic phase was prevented by dissolution of Ag precipitates and migration of Ag atoms at temperatures below that necessary for formation of the glass ceramic phase. Crystallization was demonstrated after low-temperature or low-dose-rate implantations. Optical spectroscopy was used to monitor the size of colloidal Ag particles and to detect the presence of the crystalline phase. Rutherford backscattering spectroscopy (RBS) was used to obtain the depth distribution of Ag atoms in the glass and thus monitor Ag migration. For samples implanted at room temperature and at relatively high dose rates (~1 $\mu A/cm^2$), aggregation of the Ag atoms into colloids occurred during implantation and also during subsequent annealing to temperatures < or =350 degreeC. The RBS spectra indicate some migration of the Ag to the surface at these temperatures. For annealing temperatures <350 degreeC, both optical and RBS measurements show that Ag is lost from the glass surface. The initial spatial distribution of the Ag for these high-dose-rate room-temperature implantations was distorted by interactions with the associated damage and possibly by local electric fields caused by neutralization of the implanted ions. It was possible to obtain dispersed Ag nuclei by implanting at low sample temperatures (80 K) or at low beam current (~200 nA/cm^2) to reduce ion-beam heating. Although some migration to the surface was seen in these samples, it occurred at higher temperatures and crystalline precipitation was achieved by annealing at 500 degreeC.

32887 Cathodoluminescence studies of anomalous ion implantation defect introduction in CdTe. Norris, C.B.; Barnes, C.E.; Zanio, K.R. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **48**: No. 4, 1659-1667(Apr 1977).

Shallow 100-keV Xe^+ ion implantations in CdTe are shown to introduce at least two species of 300 K-stable defect complexes to depths of at least several thousand angstroms beyond the calculated projected ion range. The predominant defect species, which is nonradiative in the range 1—1.6 eV, produces severe quenching of the native 1.4-eV cathodoluminescence excited from micron depths. Measurements of the injection level dependence of the quenched 1.4-eV luminescence show that the quenching occurs primarily through the introduction of additional recombination centers rather than through the annihilation of native luminescence centers. Another defect species gives rise to an implantation-induced band near 1.2 eV. The 1.2-eV defects are more localized than the quenching defects and appear to be concentrated primarily at depths of several thousand angstroms beyond the projected ion range. Our experiments, which were performed on Te-rich donor-compensated CdTe, show that the anomalous defect introduction is sensitive to whether the donor doping is present on the Cd sublattice or on the Te sublattice. In comparison to Cl-doped material, In-doped material shows less quenching and a stronger 1.2-eV band. We also find that the production of 300 K-stable quenching centers is enhanced by implanting at 80 rather than 300 K. We conclude that all our results implicate primarily Te vacancies in the anomalous deep introduction of both the quenching centers and the 1.2-eV centers.

CHEMISTRY

32888 (NTIS/PS—0802) **Standard reference materials (a bibliography with abstracts). Report for 1964-Sep 76.** Reimherr, G.W. (National Technical Information Service, Springfield, Va. (USA)). Oct 1976. 189p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/667.

The cited reports present research concerning standard reference materials for science and industry. Fields covered include chemistry, physics, pollution detection, and metallurgy. Most of the references originated from the National Bureau of Standards; however, all NBS research on reference materials and standard methods are not covered. (This updated bibliography contains 184 abstracts, 43 of which are new entries to the previous edition.) (GRA)

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 32157, 32161, 32868

32889 (LA—6577-PR) **Analytical methods for fissionable materials in the nuclear fuel cycle. Progress report, July 1, 1975—September 30, 1976.** Waterbury, G.R. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 16p. Dep. NTIS $3.50.

Progress continued on development of dissolution techniques for difficult-to-dissolve nuclear materials, development of methods and automated instruments for determinations of plutonium and uranium, preparation of plutonium-containing materials for the Safeguards Analytical Laboratory Evaluation (SALE) program, analysis of SALE uranium materials, and measurement of plutonium isotope half-lives. Gas-solid reactions at elevated temperatures using reactive gases such as chlorine continue to show promise for separating

uranium from refractory materials. An extensive study of nonaqueous solvents for the dissolution of refractory materials is in progress. An extraction-separation procedure, highly specific for microgram amounts of uranium, has been developed, and its adaptation to the Los Alamos Scientific Laboratory (LASL) automated spectrophotometer is being evaluated. Development of an electrometric analysis method for plutonium is nearing completion, and design of an automated instrument using the method has been started. Batches of plutonium oxide and mixed uranium—plutonium, intended for issue as Secondary Reference and Calibration Test Materials, are being recharacterized for assay and isotopic contents. The half-life of ^{239}Pu has been determined by isotope-dilution mass-spectrometric measurement of ^{235}U grow-in as a function of time.

32890 (NTIS/PS—76/0617) **Chemical analysis of aerosols and airborne particulates (a bibliography with abstracts). Report for 1964—Jul 1976.** Werner, K.G.; Cavagnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). Aug 1976. 159p. NTIS (US Sales Only).

Supersedes NTIS/PS—75/527, and COM-74—11018.

Research is presented on the chemical analysis and composition of aerosols and airborne particulate matter. Techniques discussed range from chromatography to various methods of activation and spectroscopic analysis. Particle sampling techniques and particle size analysis are excluded. (This updated bibliography contains 154 abstracts, 52 of which are new entries to the previous edition.) (GRA)

32891 (LA-tr—77-2) **Methods for accurate determination of uranium.** Spevackova, V.; Krtil, J. Translated from *Jad. Energ.;* **21**: No. 8, 294-297(1975). 14p. Dep. NTIS $3.50.

This study is a review of important methods for the determination of uranium. Attention is paid mostly to those methods which determine the concentration of uranium very accurately, and are reproducible and procedurally simple. (59 references)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 32158

32892 (ARH-CD—758) **Atlantic Richfield Hanford Company californium multiplier/delayed neutron counter safety analysis.** Zimmer, W.H. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Aug 1976. Contract EY-76-C-06-2130. 53p. Dep. NTIS $4.50.

The Californium Multiplier (CFX) is a subcritical assembly of uranium surrounding ^{252}Cf spontaneously fissioning neutron sources; its function is to multiply the neutron flux to a level useful for activation analysis. This document summarizes the safety analysis aspects of the CFX, DNC, pneumatic transfer system, and instrumentation and to detail all the aspects of the total facility as a starting point for the ARHCO Safety Analysis Review. Recognized hazards and steps already taken to neutralize them are itemized. (DLC)

32893 (NTIS/PS—76/0980) **Archaeology: site studies, activation analysis, preservation, and remote sensing (a bibliography with abstracts). Report for 1964-Nov 76.** Lehmann, E.J. (National Technical Information Service, Springfield, Va. (USA)). Dec 1976. 140p. Q 07/MF/A01.

Supersedes NTIS/PS—75/859.

This bibliography was prepared in order to bring together Federally funded research relating to archaeology. It is divided into two sections. The first deals with the chemical analysis of archaeological specimens primarily using activation analysis. Articles studied include metals, pottery, coins, paintings, soils, glass, and paper from Medieval, Grecian, Egyptian, Mayan, and prehistoric times. The second section cites other archaeological research including results of excavations from all over the United States. Also covered is work on preservation of artifacts and remote sensing for site location. (This updated bibliography contains 135 abstracts, 18 of which are new entries to the previous edition.) (GRA)

32894 Instrumental activation analysis of coal and fly ash with thermal and epithermal neutrons and short-lived nuclides. Steinnes, E. (Institutt for Atomenergi, Kjeller (Norway)); Rowe, J.J. (Geological Survey, Reston, Va. (USA)). *Anal. Chim. Acta;* **87**: No. 2, 451-462(Dec 1976).

15 refs., 5 tables.

Instrumental neutron activation analysis is applied to the determination of about 25 elements in coals and fly ash by means of nuclides with half-lifes of less than 48 h; thermal and epithermal irradiations are used. The results indicate that epithermal activation is preferable for twelve of the elements (Ga, As, Br, Sr, In, Cs, Ba, La, Sm, Ho, W and U). Data for SRM 1632 (coal) and SRM 1633 (fly ash) compare favorably with the results obtained by other investigators.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 31883, 32021, 32900, 33144

32895 (UCRL-Trans—11215) **Determination of sulfide sulfur in industrial cyanides and potentiometric titration of black cyanide solutions.** Raines, M.M.; Putning, A.R. Translated from *Zavod. Lab.;* No. 6, 811-815(1937). 14p. Dep. NTIS $3.50.

Potentiometric titration of sulfides in the presence of cyanides, chloride, thiocyanates, etc. yield results which coincide with the currently most accurate methods for determining sulfide sulfur. The method of potentiometric titration of sulfides, thiocyanates, cyanides, and chlorides may be recommended for analysis of cyanide solutions. The equipment used for potentiometric titration is very simple and easy to set up under conventional laboratory conditions.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 32066, 32158

32896 (INT—92/I) **Application of radioactive tracers in the technological processes investigation. Proceedings of the Polish symposium held in Zakopane, Poland, 21—25 October 1975.** (Institute of Physics and Nuclear Techniques, Krakow (Poland)). 1976. vp. (CONF-751093—P7). NTIS (US Sales Only).

From Symposium on progress in nuclear technique and applications in science and industry; Zakopane, Poland (21 Oct 1975).

It is important to be able to reveal the whole of the microstructural changes in the fuel-cladding interaction zone. Compatibility couples of austenitic stainless steels (DIN 1.4401, 1.4970, 1.4981, 1.4988) and hyperstoichiometric UO_2 to which elements were added to simulate a 10% burn-up, were used in this out-of-pile study. A variety of reaction products are formed in the contact surface layers and further along the grain boundaries of the scanning material, but the transport of alloy elements which take part in these reactions can cause contiguous microstructural changes. A detailed description is given of two metallographic techniques appropriate for optical analysis of all the reaction zones present, one based on the application of epitaxial films and the other on the application of interference film microscopy; their respective results are compared.

32897 (LA—6701-MS) **SAMAC Analytical Notes II: preliminary results of x-ray fluorescence analysis of archeological materials from southeastern Utah.** Snow, D.H.; Fullbright, H.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 15p. Dep. NTIS $3.50.

A series of prehistoric potsherds, local clay samples, and possible tempering materials from archeological excavations in southeastern Utah have been examined by x-ray fluorescence spectroscopy. The results obtained for this small sampling demonstrate the usefulness of the technique in characterizing the clays, the potsherd pastes, and the decorative pigments.

32898 Energy dispersive x-ray fluorescence spectrometry for determination of twenty-six trace and two major elements in geochemical specimens. Giauque, R.D.; Garrett, R.B.; Goda, L.Y. (Univ. of California, Berkeley). *Anal. Chem.;* **49**: No. 1, 62-67(Jan 1977).

A method for analyzing geochemical specimens by energy dispersive x-ray fluorescence is described. The fact is used that at any given x-ray energy between adjacent major element absorption edges, both the reciprocal of the specimen mass absorption coefficient and the spectral background intensity vary linearly with the intensity of the Compton scattered excitation radiation. Hence, Compton scattered excitation radiation serves a dual role: as an internal standard and as a measure of spectral background intensity. Several pure compounds, for which the x-ray cross sections vary over a wide range, are used to develop individual x-ray line spectral background curves. Standardization is achieved utilizing geochemical reference standards. Accuracies typically obtained are 5% or better using 20-in analysis periods.

32899 Mass counting of radioactivity samples. Oesterlin, D.L.; Obrycki, R.F. (to G. D. Searle and Co.). US Patent 4,005,292. 25 Jan 1977. Filed date 12 May 1975. 12p.

A method and apparatus for concurrently counting a plurality of radioactive samples is claimed. The position sensitive circuitry of a scintillation camera is employed to sort electrical pulses resulting from scintillations according to the geometrical locations of scintillations causing those pulses. A scintillation means, in the form of a scintillating crystal material or a liquid scintillator, is positioned proximate to an array of radioactive samples. Improvement in the accuracy of pulse classification may be obtained by employing collimating means. If a plurality of scintillation crystals are employed to measure the iodine-125 content of samples, a method and means are provided for correcting for variations in crystal light transmission properties, sample volume, and sample container radiation absorption. 2 claims, 7 drawing figures.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 32566, 32935, 33143, 33269

32900 (TRG-Report—2799(S)) **Reactor applications of quantitative diffraction analysis.** Feguson, I.F. (ed.). (UKAEA Reactor Group, Risley). Sep 1976. 112p. NTIS (US Sales Only).

From UKAEA diffraction analysis conference; Springfields, UK (14 Oct 1975).

Available from H.M. Stationery Office, price Pound 2.50.

Current work in quantitative diffraction analysis was presented under the main headings of: thermal systems, fast reactor systems, SGHWR applications and irradiation damage. Preliminary results are included on a comparison of various new instrumental methods of boron analysis as well as preliminary new results on Zircaloy corrosion, and materials transfer in liquid sodium.

32901 **Use of a stilometer for flame photometry with an internal standard.** Radyanskii, V.M.; Kurtasova, L.Z. *J. Appl. Spectrosc. (USSR) (Engl. Transl.);* **18**: No. 5, 665-666(May 1973).

Use of a two-channel photoelectric stilometer for improving accuracy and sensitivity in determining Na, K, Li, Rb and Cs by flame photometry using internal standards is discussed. 4 refs.

32902 (BNWL-tr—227) **Spectrometric study of a plasma induced by high frequency. Part I. Analytical performances.** Abdallah, M.H.; Diemiaszonek, R.; Jarosz, J.; Mermet, J.M.; Robin, J.; Trassy, C. Translated from *Anal. Chim. Acta;* **84**: 271-282(1976). 19p. Dep. NTIS $3.50.

A new high-frequency plasma generator operating at 40 MHz was designed as an excitation source for atomic emission spectroscopy and as a dissociation source in atomic absorption. Good analytical performances were obtained in atomic emission and absorption. Nevertheless, emission is preferred because of its operational simplicity. (auth)

32903 **Pulsed nuclear magnetic resonance spectrometry for nondestructive determination of hydrogen in coal.** Gerstein, B.C.; Pembleton, R.G. (Ames Lab., IA). *Anal. Chem.;* **49**: No. 1, 75-77(Jan 1977).

Initial values of free induction decays are shown to yield a rapid, nondestructive quantitative measure of protons in coals provided: an appropriate in A(t) = the extrema in the oscillations of the free induction decay vs. time plot is made; the zero of time is chosen to be the center of the pulse; the pulse width for a 90° pulse is not longer than T_2^* = effective spin-lattice relaxation time of the system/4; recovery time of the receiver—dc amplifier system is of the order of the pulse width; both coal sample and calibration sample are exposed to a uniform rf field; and the calibration sample is measured under the same experimental conditions as is the coal sample.

32904 **Colorimetric determination of niobium in sodium metal with thiocyanate.** Sattler, P.F.; Schreinlechner, I.E. (Institut fur Metallurgie, Vienna). *Anal. Chem.;* **49**: No. 1, 80-82(Jan 1977).

The niobium determination using the spectrophotometric measurement of the thiocyanate complex is applied for the determination of trace amounts of niobium in sodium. The effects of the concentration of the reagents on the absorbance were studied resulting in the optimization of the conditions for the color development of the complex. The procedure is recommended in the range of up to 10 μg niobium, whereby a detection limit of 0.040 μg Nb ml^{-1} cm^{-1} is obtained.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 31767, 31869, 32024, 32075, 32112, 32126, 32133, 32134, 33183

32905 (INIS-mf—3283, pp 28-29) **Investigation into americium extraction process from residues of irradiated nuclear fuel after its fluorination by SiF-NaF and SiF-CaF_2 melts of eutectic composition.** Khomyakov, V.I.; Shishkov, Yu.D.; Galkin, N.P. 1976. (In Russian).

From All-union conference on chemistry of transplutonium elements (americium, curium, berkelium, californium); Dimitrovgrad, USSR (29 Jun 1976).

Published in summary form only.

In All-union conference on chemistry of transplutonium elements (americium, curium, berkelium, californium) .

32906 **Rapid resolution of 5'-mono-, -di-, and -triphosphate ribo- and deoxyribonucleoside mixtures by conventional anion-exchange chromatography.** Khym, J.X. (Oak Ridge National Lab., TN). *J. Chromatogr.;* **124**: 415-417(1976).

A method is described for separation of ribo- and deoxyribo-5'-nucleosides at the mono-, di-, and triphosphate levels on a column of the citrate form of Aminex A-28. A gradient delay and a lower initial pH are used to effect a good separation. The gradient delay allows the solute bands of closely eluting species to become somewhat separated on the column at low citrate concentrations before the bands are removed from the column by increasing the citrate concentrations of the gradient. (BLM)

32907 **Application of a pretreated straw column to the separation of thorium and uranium.** Dai, M.H.; Lu, W.D.; Wu, S.C. (Inst. of Nuclear Energy Research, Lung-Tan, Taiwan). *Sep. Sci.;* **11**: No. 6, 541-551(1976).

Straw pretreated with concentrated nitric acid has been used as an adsorbent in columns. This adsorbent has been shown to possess high adsorbability and high affinity for thorium, and it is based on this property that the pretreated straw is used to separate thorium from uranium and its daughters. The affinity of this column for thorium and uranium was studied, and a number of eluants have been investigated for the desorption. We found that several economical ammonium salts [0.2 M $(NH_4)_2SO_4$, 1 N $(NH_4)_2CO_3$, 1.5 N NH_4Cl, and 2 N NH_4NO_3] could be used for the separation of thorium and uranium successfully. Finally, this column was successfully used to separate trace amounts of thorium from uranyl nitrate hexahydrate and to remove the daughters from thorium nitrate dodecahydrate.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 31754, 31766, 32180, 32182, 32933

32908 (BNL—22113) **Steam catalysis of limestone calcination: literature review.** Senum, G.I. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1976. Contract EY-76-C-02-0016. 16p. Dep. NTIS $3.50.

Seven papers that have appeared in the literature since 1945 on this topic are reviewed. The rate of thermal decomposition of limestone ($CaCO_3$ yields $CaO + CO_2$) is controlled by three major rate processes (heat transfer, mass transfer, chemical reaction). The possible catalytic effect of steam is examined. The literature review indicates that steam is a chemical catalyst and that the degree of catalysis decreases with temperature. A possible mechanism is proposed. (DLC)

32909 (IS-T—749) **Interaction of nitric oxide wth the (1010) face of ruthenium.** Orent, T.W. (Ames Lab., Iowa (USA)). Feb 1977. Contract W-7405-ENG-82. 104p. Dep. NTIS $5.50.

Thesis.

The low-energy electron diffraction (LEED) technique was used to probe the atomic geometry of the surfaces that resulted from the steady-state interaction of nitric oxide with Ru(10 anti 10) as a function of temperature and pressure. Auger electron spectroscopy (AES) was used to identify the atomic species present on these surfaces. Results were obtained at reactant partial pressures in the range from 10^{-9} to 10^{-6} torr and substrate temperatures from -25 to 950°C. The interaction of molecular oxygen with the surface was also examined. A qualitative correlation exists between the observed structures and the reported enhancement in the catalytic activity of supported ruthenium after the catalyst had been pretreated with oxygen. (JRD)

32910 (LA-UR—76-2500) **Silica scale technology and water conservation.** Midkiff, W.S.; Foyt, H.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-38. 11p. (CONF-770303—8). Dep. NTIS $3.50.

From Corrosion/77 NACE meeting; San Francisco, California, United States of America (USA) (14 Mar 1977).

Conservation of water at the Los Alamos Scientific Laboratory (LASL) has been accomplished by recirculating evaporative cooling waters. Because of high silica concentration (80 mg/l) in Los Alamos groundwater, the concentration of recirculating water must be carefully controlled to prevent scaling. The most troublesome scale at Los Alamos has been identified as colloidal silica bound in a crystalline matrix of calcium carbonate. Several approaches to controlling this scale are: (1) chemical treatment using a chelate, sequestrant, or threshold approach, (2) softening, or (3) pH control. Silica alone will form deposits when supersaturated. In LASL systems, where silica concentrations are 200 to 240 mg/l, no problems have been observed. However, there is evidence that deposits are forming at slightly higher concentrations. These amorphous silica deposits are not as hard and tenacious as the calcium carbonate—silica scale. Complete external treatment, which combines silica removal and water softening, may be an economically competitive process for scale control. The advantages of slightly reducing the quantity of makeup water and drastically reducing the amount of blowdown water have environmental and conservation implications that may encourage the selection of complete treatment.

32911 (NTIS/PS—76/0688) **Carbon and graphite. Part 4. Graphite—chemical properties (a bibliography with abstracts). Report for 1964-Jun 76.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 150p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/616.

The research citations cover the chemistry of graphite. Included are studies on vaporization, thermodynamics, surface chemis-

try, intercalation compounds, chemisorption, and oxidation. (This updated bibliography contains 145 abstracts, 20 of which are new entries to the previous edition.) (GRA)

32912 (ORNL-tr—4265) **Kinetics of nitrous acid reactions. V-VI.** Abel, E.; Schmid, H.; Babad, S. Translated by S.D. Blalock Jr. from *Z. Phys. Chem. (Leipzig);* **136**: 419-436(1928). 17p. Dep. NTIS $3.50.

The classical equilibrium constant K/sub e/ of the HNO_2—HNO_3—NO reaction was determined and found to increase with ion concentration. When activity coefficients for HNO_3 were introduced into K/sub c/, values (anti K) were obtained which varies only slightly with ion concentration, and extrapolation leads to $K = a(H^+)\, a(NO_3^-)\, p^2(NO)/a^3(HNO_2) = 29$ at 25°C. The reaction rate constants are: k^1/sub I/ = 46 and k_2^1 = 1.6 at 25°C. (DLC)

32913 **Evaporation losses during handling of liquid helium.** Engel, J.; Klipping, G.; Walter, H. (Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin). pp 267-271 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Handling of LHe implies storage in large containers and distribution of smaller amounts to the customers. Considerable evaporation losses occur during expansion and transfer of LHe. The losses connected with the different steps of transfer are estimated from thermodynamic data. Possibilities of economizing the distribution and minimizing the losses of LHe are discussed.

32914 **Cryogenic liquid boiling in inhomogeneous magnetic field.** Verkin, B.I.; Kirichenko, Y.A.; Charkin, A.I. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 292-294 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The effect of inhomogeneous magnetic field on departure frequencies and diameters, heat transfer coefficients and critical heat fluxes is studied under oxygen pool boiling. The results found are analyzed.

32915 **Structure of adsorbed gas monolayers.** Buchholz, J.C.; Somorjai, G.A. (Univ. of California, Berkeley). *Acc. Chem. Res.;* **9**: No. 9, 333-338(Sep 1976).

Some recent work aimed at understanding the structure of adsorbed monolayers and its role in determining the chemical reactivity of a surface is reviewed. The phenomenon of ordered adsorption is discussed with the object of determining what the study of the structure of adsorbed monolayers reveals about the basic interaction at a surface. Studies of adsorbed monolayers important to reactions at the surface are discussed. Studies related to the effect of surface defects on the structure of adsorbed monolayers are discussed. (BLM)

32916 **Quasiclassical trajectory studies of reactive energy transfer.** Thompson, D.L. (Los Alamos Scientific Lab., NM). *Acc. Chem. Res.;* **9**: No. 9, 338-344(Sep 1976).

Quasiclassical trajectory studies of the reactive vibrational relaxation mechanism in atom-diatom collisions and related aspects of energy transfer are discussed. The goal of the reported work was to obtain a detailed understanding of the mechanistic processes for energy transfer in simple systems, and to develop techniques for computing reliable energy transfer data. The quasiclassical trajectory approach was shown to be a useful tool for accomplishing this goal. The usefulness does, however, rest upon the capability of computing accurate potential-energy surfaces. Carefully constructed semiempirical surfaces are shown to be quite reliable for a large number of systems.

32917 **Metal—metal bonding in reduced scandium halides. Synthesis and crystal structure of scandium monochloride.** Poeppelmeier, K.R.; Corbett, J.D. (Ames Lab., IA). *Inorg. Chem.;* **16**: No. 2, 294-297(Feb 1977).

The synthesis of a number of reduced scandium chlorides is achieved by reaction of excess metal with $ScCl_3$ in sealed Ta tubing above 877°C for periods of weeks to months. Extreme conditions are necessary because of both the kinetic problems of forming extended metal—metal bonded structures and the fact that $ScCl_{1.5}$ effectively blocks further reaction on metal surfaces below this temperature. Single-crystal x-ray diffraction data showed that a gray-black laminar phase was ScCl with a sheet structure consisting of close-packed homoatomic layers sequenced Cl—Sc—Sc—Cl along [001] (R3m, trigonal cell; a = 3.473 (2) A, c = 26.71 (4) A, Z = 6; R = 0.088, R/sub w/ = 0.101 for 79 independent reflections taken with Mo Kα radiation). The phase is thus polytopic (ignoring the difference in metal atom) with ZrCl and isostructural with ZrBr even though there are only two-thirds as many electrons for bonding the double-metal sheets of scandium. The general occurrence of metal-metal bonding in clusters, ribbons, and sheets in transition metal groups 3—5 is considered.

32918 **Crystal and molecular structure of ferricenium tetrachlorobismuthate.** Mammano, N.J.; Zalkin, A.; Landers, A.; Rheingold, A.L. (Univ. of California, Berkeley). *Inorg. Chem.;* **16**: No. 2, 297-300(Feb 1977).

Ferricenium tetrachlorobismuthate, $(C_5H_5)_2Fe_2BiCl_4$, crystallizes in the monoclinic space group $P2_1/c$ with a = 10.998 (5) A, b = 17.449 (4) A, c = 7.569 (4) A, β = 98.46 (5)°. There are four molecules in the unit cell. Reflection intensities were measured by the theta-2 theta scan method with a Picker FACS-1 automated diffractometer, Mo Kα radiation, and a graphite monochromator. For 1374 data with F^2 greater than 3 sigma(F^2), R_1 = 0.030 and R_2 = 0.037. The Bi atom is coordinated by six chloride ions in an irregular octahedral array; two pairs of Cl^- ions form halogen bridges with neighboring Bi ions resulting in an infinite chain of edge-sharing octahedra. There are six independent Bi—Cl bond distances: 2.50 (1) and 2.52 (1) A to nonbridging chlorines and 2.70 (1), 2.75 (1), 2.95 (1) and 3.10 (1) A to bridging chlorines. The bridging Cl—Bi—Cl bond angles are 80.3 and 83.9°, the ten nonbridging Cl—Bi—Cl bond angles range from 85.9 to 99.3°. The axial Cl—Bi—Cl bond angles are 166.0, and 174.5, and 175.9°. The ferricenium cations stack between the polymer chains with cyclopentadiene rings in the eclipsed conformation, unlike the pure ferrocene molecule which shows staggered rings. The average C—C distance in the rings is 1.40 (2) A, the distance between ring centers is 3.40 (2) A, and the Fe-ring center distance is 1.70 (2) A.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 32090, 32094

32919 **Method and device for separating gaseous or vaporous materials, especially isotopes, by means of separation nozzles.** Becker, E.W.; Ehrfeld, W.; Eisenbeiss, G. (to Gesellschaft fuer Kernforschung mbH). US Patent 3,989,483. 2 Nov 1976. Priority date 1 Aug 1973, German, Federal Republic of (F.R. Germany). 12p.

A method is provided for separating gaseous or vaporous substances, especially isotopes, with different molecular weights and/or different gas kinetic cross sections, in which the mixture of substances to be separated is passed through separation nozzles. One or more skimmer diaphragms project into the flow path of the substances and are used to separate and remove fractions of different compositions, and several separation systems consisting of nozzles and skimmer diaphragms are arranged in a cascade. The cascade generates partial streams which contain the mixture of substances to be separated. The partial streams can contain an additional gas with each partial stream containing different fractions of additional gas. When the partial streams generated within the cascade contain different fractions of additional gas, the partial streams are jointly fed to one of the separation nozzle systems in such a way as to generate a molar fraction gradient with respect to the additional gas which is opposed in direction to the molar fraction gradient being generated by the separation process within the nozzle. The partial streams can contain different compositions of the mixture of substances to be separated. When the partial streams generated within the cascade contain different compositions of the mixture of substances to be separated, the partial streams are jointly fed to one of the separation nozzle systems in such a way as to generate a molar fraction ratio with respect to the substances to be separated which is identical in direction with the molar fraction gradient being generated by the separation process within the nozzle. 27 claims, 13 figures.

32920 **Catalyst for hydrogen-amine D exchange.** Holtslander, W.J.; Johnson, R.E. (to Atomic Energy of Canada Ltd.). US Patent 3,995,017. 30 Nov 1976. Priority date 31 Jul 1973, Canada. 6p.

A process is claimed for deuterium isotopic enrichment (suitable for use in heavy water production) by amine-hydrogen exchange in which the exchange catalyst comprises a mixture of alkyl amides of two metals selected from the group consisting of the alkali metals. Catalyst mixtures comprising at least one of the alkali amides of lithium and potassium are preferred. At least one of the following benefits are obtained: decreased hydride formation, decreased thermal decomposition of alkyl amide, increased catalyst solubility in the amine phase, and increased exchange efficiency. 11 claims.

32921 **Effects of specific surface treatments on type 304 stainless steel.** Bonham, R.W.; Holloway, D.M. (General Electric Company, Neutron Devices Department, St. Petersburg, Florida 33733). *J. Vac. Sci. Technol.;* **14**: No. 2, 745-746(Mar 1977).

Proterctive coatings for stainless steel containers for deuterium/tritium gas mixtures (gas mass spectrometer calibration standards) have been evaluated by auger electron spectroscopy. An iron/oxygen rich coated surface minized isotopic exchange. (AIP).

32922 **Control of collisionless and collisional processes by nonresonant laser fields.** Lau, A.M.F.; Rhodes, C.K. (Molecular Physics

Center, Stanford Research Institute, Menlo Park, California 94025). *Phys. Rev., A;* **15**: No. 4, 1570-1587(Apr 1977).

The presence of coherent radiation fields can modify various atomic, ionic, and molecular processes. Cases were examined where the changes can be effected without actual absorption or emission of photons. The radiation fields cause optical Stark shifts of the energies and dress the nonadiabatic couplings between states. Rates of processes such as dissociation, predissociation, atomic and molecular collisions can be radiatively controlled. Formation of new avoided crossings due to radiative interaction gives rise to new phenomena. B exact numerical results from which the influences of the radiation field on arbitrary configurations can be calculated, and simple but accurate analytic results, from which these effects can be conveniently assessed are given. It is shown that the inelastic transition probability is decreased at a true crossing and is increased at an avoided crossing as a result of the presence of the nonresonant radiation field. Furthermore, for two parallel levels with constant nonadiabatic coupling, it is shown that the amplitudes of the nonadiabatic transition are invariant, but its flopping frequency is reduced by the field. Depending on the kinds of final measurements with the field on or off, general behaviors of the inelastic transition probability as a function of the field parameters and the charge-system parameters are predicted and the possibility of inversion (from a field-free value of less than 1/2 to a value greater than 1/2) is demonstrated. Experimental investigation with iodine molecules is suggested. Comparison of nonperturbative results with those of stationary perturbation theory shows that the latter is inadequate in an important parameter region where the field modification of processes is greater than 1%.

ORGANIC CHEMISTRY

REFER ALSO TO CITATION(S) 31879, 31989

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 32918, 32933, 33190

32923 (Y/DK—173) **Vapor phase infrared spectra of epoxy resin components.** Chambles, A. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1 Feb 1977. Contract W-7405-ENG-26. 70p. Dep. NTIS $4.50.

High resolution vapor phase spectra of Bis- (4-aminophenyl) methane (MDA), diglycidyl ether of bis-phenol A; n = 0.2 (DGEBA), dichloromethane [methylene chloride (MC)], Bis- (2,3-epoxycyclopentyl) ether (ECPE), and 1,3-diaminebenzene [metaphenylenediamine (MPDA)] were measured. Quantitative measurements of the methylene chloride bands seem to have a reasonable degree of accuracy. However, quantitative measurements of ECPE and MPDA are very uncertain. The uncertainty results from the difficulty (1) of injecting a measured quantity of these compounds into the 20-meter gas cell and insuring that all have vaporized, and (2) of obtaining equilibrium conditions between solid/liquid and vapor. (JRD)

32924 **Crystal and molecular structure of trans-biphthalyl, $C_{16}H_8O_4$. Reaction of substituted phthalic anhydrides with trialkyl phosphites.** Ramirez, F.; Ricci, J.S. Jr.,; Tsuboi, H.; Marecek, J.F.; Yamanaka, H. (State Univ. of New York, Stony Brook). *J. Org. Chem.;* **41**: No. 24, 3909-3914(26 Nov 1976).

The crystal and molecular structure of trans-biphthalyl, the main product of the reaction of phthalic anhydride with triethyl phosphite, has been elucidated by x-ray crystallographic techniques. The yellow substance crystallizes in the monoclinic system, space group P2/sub 1/c/ with four asymmetric units per unit cell. The structure was refined by full-matrix least-squares techniques to a final R factor on F of 3.5% based on 571 observations above background. The molecule is planar, and some of the bond angles formed by the trigonal carbon atoms are significantly larger ($\Delta \sim 12^0$) than the normal 120^0 value. It is suggested that the flexibility inherent in C—C—C, C—C—O, and C—O—C bond angles permits (a) the observed angle expansions which are required to allow for coplanarity of the chromophore O=C—C=C—C=C—C=C—C=O in the crowded molecule; and (b) the observed angle contractions, which are required to establish the five-membered rings. This effect accounts for the existence of octaphenyl-, octachloro-, and octabromo-trans-biphthalyl, although there is no assurance that the octahalo compounds have completely planar molecules.

32925 **Electron-impact and pyrolytic eliminations from 4-tert-butylcyclohexyl xanthates.** Eadon, G.; Jefson, M. (State Univ. of New York, Albany). *J. Org. Chem.;* **41**: No. 24, 3917-3920(26 Nov 1976).

The stereochemistry of electron—impact induced xanthic acid elimination reactions was assessed by mass spectrographic studies of cis and trans deuterated 4-tert-butylcyclohexyl xanthates and their derivatives. Cis elimination was observed to be about 30 times as facile as trans elimination in the axial xanthate reaction. In the equatorial ester derivative reactions, the cis elimination was found to be slightly preferred. The electron-impact induced elimination results were compared with pyrolytic elimination results for the xanthates; and similar stereochemistry was observed for each type of elimination. (DDA)

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 32925

32926 **Raman study of vibrational dephasing in liquid CH_3CN and CD_3CN.** Schroeder, J.; Schiemann, V.H.; Sharko, P.T.; Jonas, J. (Department of Chemistry, School of Chemical Sciences and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). *J. Chem. Phys.;* **66**: No. 7, 3215-3226(1 Apr 1977).

The Raman line shapes of the $\nu_1(a_1)$ C—H and C—D fundamentals in liquid acetonitrile and acetonitrile-d_3 have been measured as a function of pressure up to 4 kbar within the temperature interval 30—120 degreeC. Densities have also been determined. From the isotropic component of the vibrational Raman band shape the vibrational relaxation times have been obtained as a function of temperature and pressure (density). The experimental results can be summarized as follows: (i) as T increases at constant density rho, the vibrational relaxation rate (tau/sub vib/)$^{-1}$ increases; (ii) at constant T as density is raised tau/sub vib/$^{-1}$ increases; (iii) at constant pressure the T increase produces higher tau/sub vib/$^{-1}$, however, the change is more pronounced for the CD_3CN liquid. Isotopic dilution studies of the CH_3CN/CD_3CN mixtures shows no significant effect on (tau/sub vib/$^{-1}$). The experimental data are interpreted in terms of the Kubo stochastic line shape theory and the dephasing model of Fischer and Laubereau. The results based on Kubo formalism indicate that dephasing is the dominant relaxation mechanism and that the modulation is fast. The isolated binary collision model proposed by Fischer and Laubereau for vibrational dephasing reproduces the essential features of the density and temperature dependence of the (tau/sub vib/)$^{-1}$ and suggests that pure dephasing is the dominant broadening mechanism for the isotropic line shapes studied. In the calculation the elastic collision times were approximated by the Enskog relaxation times.

PHOTOCHEMISTRY

32927 **Photochemical reactions of aqueous plutonium systems. II.** Friedman, H.A.; Toth, L.M.; Bell, J.T. (Oak Ridge National Lab., Tenn. (USA)). *J. Inorg. Nucl. Chem.;* **39**: No. 1, 123-126(1977).

The photochemical shift of the Pu^{4+} disproportionation equilibrium in aqueous perchloric acid solutions has been measured and shown to be reversible. Ratios of equilibrium quotients between light and dark conditions have been measured for 0.01 M Pu ion concentrations in 0.53 to 1.24 N acid solutions exposed to 0.5 Watt of UV light. The photodecomposition of time- and temperature-aged Pu(IV) polymers in perchloric and nitric acid solutions have been examined as a function of aging conditions. Effects similar to those seen previously for fresh polymers have been observed in the aged perchloric acid solutions.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 32164, 32173, 32931

32928 **Solvation processes of the electron in polar liquids. II. Continuum model.** Tachiya, M.; Watanabe, H. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **66**: No. 7, 3056-3060(1 Apr 1977).

The solvation process of the electron in polar liquids is investigated within the framework of the continuum model. The medium is assumed to be a continuous dielectric characterized by the static dielectric constant ϵ/sub s/, the optical dielectric constant ϵ/ sub op/, and the relaxation time tau. The motion of the excess electron and the relaxation of the medium are treated consistently. The former is treated quantum mechanically and the latter classically. The time evolution of the wavefunctions, polarization, energy levels, and transition energy is calculated.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 32074, 32927

32929 (KURRI-TR—125) **Symposium on radioiodine held in Kumatori, Osaka, Japan, 24 October 1973.** Katsurayama, K.; Tsujimoto,

T. (eds.). (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). 1974. vp. (CONF-7310127—). NTIS (US Sales Only).

From Symposium on radioiodine; Kumatori, Osaka, Japan (24 Oct 1973).

Individual papers were indexed separately for the data base. (JSR)

32930 Radioactive erbium-165 complexes and methods of preparation and use thereof. Dandamudi, V.R. (to Albert Einstein College of Medicine of Yeshiva Univ.). US Patent 3,995,020. 30 Nov 1976. Filed date 23 May 1975. 2p.

Complexes based on erbium-165 are disclosed. Such materials, particularly the citrate, are useful for imaging of cardiac infarcts and tumors, especially adeno-carcinomas and sarcomas. Excellent resolution with low energy photons is obtained, particularly with the use of multiwire proportional cameras. 5 claims.

32931 Effects of aging and self-irradiation on crystalline ^{147}promethium trihydroxide. Haire, R.G. (Oak Ridge National Lab., Tenn. (USA)); Dillin, D.R.; Milligan, W.O.; Beasley, M.L. *J. Inorg. Nucl. Chem.;* **39**: No. 1, 53-57(1977).

Precipitation of ^{147}promethium trihydroxide from aqueous solutions yields amorphous particles 10 to 15 A in diameter. Aging of these particles in water results in the formation of crystalline, rod-like structures of the trihydroxide, which are isomorphous with the other known hexagonal lanthanide trihydroxides. The lattice constants for the pure ^{147}promethium compound were determined to be $a_0 = 6.396 +- 0.003$ A and c_0 3.707 +- 0.003 A. These values are in excellent agreement with lattice constants for promethium trihydroxide predicted from a linear relationship of several lanthanide isomorphs but differ slightly from previously reported values by Weigel and Scherrer of $a_0 = 6.39$ A and $c_0 = 3.68$ A. The ^{147}promethium trihydroxide crystals were periodically examined over one half-life of ^{147}Pm to determine the effects of self-irradiation by β particles and the transmutation of the Pm to Sm. The data show that the self-irradiation damage to the crystals is minor as compared to extensive effects by high energy α particles previously observed in ^{244}curium trihydroxide. Analysis of the ^{147}promethium trihydroxide crystals by electron and X-ray diffraction after one half-life of the ^{147}Pm had passed gave lattice parameters which were approximately equal to the averages of values for promethium and samarium trihydroxides; the measured values were $a_0 = 6.382 +- 0.003$ A and $c_0 = 3.690 +- 0.002$ A.

32932 Absorption spectrum of $KAm(C_8H_8)_2$ in the THF solution. Karraker, D.G. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). *J. Inorg. Nucl. Chem.;* **39**: No. 1, 87-89(1977).

Comparison of the absorption spectrum of $KAm(C_8H_8)_2$ in THF solution with Am^{3+} spectra in aqueous solution shows a shift of 450 to 200 cm^{-1} toward longer wavelengths; the shift indicates a small degree of covalency in the bonding between Am^3 and the $C_8H_8^{2-}$ ligand. The ratio of ^{244}Cm to ^{243}Am was unchanged through the reactions involved in the synthesis of $KAm(C_8H_8)_2$. No evidence was found for an Am^{2+} species after treating $KAm(C_8H_8)_2$ solutions in THF with potassium naphthanide or n-butyl lithium.

32933 Crystal structures of aquotris(salicylato)samarium(III), and aquotris(salicylato)americium(III). Burns, J.H.; Baldwin, W.H. (Oak Ridge National Lab., TN). *Inorg. Chem.;* **16**: No. 2, 289-294(Feb 1977).

Two isostructural compounds $(C_7H_5O_3)_3Sm.H_2O$ and $(C_7H_5O_3)_3Am.H_2O$ are monoclinic, space group $P2_1/c$, and have unit-cell dimensions: a = 13.641 (3) A, b = 6.752 (1) A, c = 24.202 (7) A, β = 113.24 (2)° and a = 13.69 (2) A, b = 6.762 (2) A, c = 24.14 (1) A, β = 112.89 (5)°, respectively; Z = 4. Heavy-atom methods were used to determine the structure from x-ray diffraction data. Refinement of parameters by least-squares methods was carried out using 3280 observations on the Sm compound and 1401 on the Am. The R/sub F/ values obtained were 0.037 and 0.055 for the two refinements. There are no discrete molecules of the complex in the crystal; instead each metal ion is linked to six different salicylato ions through a variety of modes in which both the carboxylate and phenolic oxygen atoms participate. Cross-linking of metal ions produces endless chains along the b axis and only van der Waals contacts exist between the chains. A total of eight atoms from the salicylato ligands plus one from a water molecule comprise the metal coordination. There is also evidence for some hydrogen bonding among the ligands. The bonding pattern within the salicylato ions is the same for all three independent ligands. It is characterized by equivalence of bond lengths to carboxylate oxygen atoms, by distortion of the benzene ring from hexagonal symmetry, by a short C—C bondto the carboxyl group, and by a short C—O bond to the hydroxyl group. Except for the carboxyl group, which is ionized, the molecular shape is the same as for salicylic acid. Analogous compounds containing La and Nd were shown to have this structure also.

RADIOISOTOPE PRODUCTION

REFER ALSO TO CITATION(S) 32125

32934 Novel method of producing radioactive iodine. Shikata, E.; Amano, H. (to Japan Atomic Energy Research Inst.). US Patent 3,998,691. 21 Dec 1976. Priority date 29 Sep 1971, Japan. 6p.

Radioactive iodine(I-131) is easily obtained by heating, at a temperature ranging from 600°C to 650°C, a tellurium oxide intermediate which was obtained by heating telluric acid or tellurium trioxide at a temperature from about 400°C to 560°C and was irradited with a neutron flux. Thus, pure I-131 is obtained without the complicated operations required in a conventional process for separation and/or purification of the product. 4 claims.

COMBUSTION CHEMISTRY

32935 Flame temperature determination by atomic absorption. Ostroumenko, P.P.; Eremenko, A.A.; Tsikora, I.L. *J. Appl. Spectrosc. (USSR) (Engl. Transl.);* **18**: No. 5, 663-664(May 1973).

Measurements of the population temperatures for levels of nickel in acetylene-air flames by using atomic absorption are discussed. 12 refs.

ENGINEERING

FACILITIES AND EQUIPMENT

32936 (UCID—17176) **Lightweight composite pressure vessels.** Hamstad, M.A.; Toland, R.H.; Chiao, T.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jun 1976. Contract W-7405-ENG-48. 35p. Dep. NTIS $4.00.

Organic and graphite fiber/epoxy pressure vessels (10.2 cm dia) were fabricated. Some were lined with alternating layers of rubber and polymer and some were lined with aluminum. The vessels were subjected to permeation tests, fatigue cycling, and burst tests. Both liners performed well. Larger pressure vessels subjected to the same tests developed leakage problems in the liners. Some of the causes of the leaks are identified and recommended solutions are given. (TFD)

32937 (UCID—17399) **Advanced technology for minimum weight pressure vessel system.** Hamstad, M.A.; Jessop, E.S.; Toland, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1977. Contract W-7405-ENG-48;NASA-INA-C-13980-C. 12p. Dep. NTIS $3.50.

Bosses were made of fiber/resin composite materials to evaluate their potential in lightweight pressure vessels. An approximate 25% weight savings over the standard aluminum boss was achieved without boss failures during burst tests. Polymer liners and metal liners are used in fiber composite pressure vessels for containment of gases. The internal support of these liners required during the filament winding process has previously been provided by dissolvable salt mandrels. An internal pressurization technique has been developed which allows overwinding the liner without other means of support and without collapse. An earlier study of polymer liners for fiber composite pressure vessels was unsuccessful in scaling up to full-scale vessels. Study was made of several additional concepts including styrene/Saran, styrene/flexible epoxy and ABS. Use of these materials still did not produce a successful large-scale polymer-lined vessel.

32938 (Y/PK—580) **Computer support for job-shop work control.** Treadwell, J.N. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1 Jun 1976. Contract W-7405-ENG-26. 10p. (CONF-761107—24). Dep. NTIS $3.50.

From Annual meeting of the American Society of Mechanical Engineers; New York, New York, United States of America (USA) (29 Nov 1976).

A general description of the Y-12 Plant's use of the computer for work control, the reasons why this particular system was chosen, the ways that order completions are reported, and the methods employed by work groups and customer engineers to interface with the system are presented. The system is an effective communication tool with the required flexibility to allow work center foremen and staff personnel to accurately plan and schedule each order processed. The plant is also able to provide information to the customer as to the status of his order on a moment's notice. (TFD)

32939 Examples of tolerances (for figures) (30 Apr 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2561).

3 drawings.

Drawings are given for various system components as examples of tolerances required. The drawings, which include a photolytic cross cell, a window flange, and an end flange, are to be used in a technical book for tolerances. (PMA)

32940 **S 1 electronic cell sorter (6 Jan 1975) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2563).

97 drawings.

Drawings are given for an electronic high-speed cell sorter for use in biolgical applications such as the measurement of the DNA content of mammalian cells. The cell, upon excitation by a laser beam, yields a short fluorescent light pulse whose duration is determined by cell velocity and beam dimensions. The light pulses are collected by an optical system, filtered to block scattered light but transmit longer wavelength fluorescence, and focused on a limiting aperture (250 μm pinhole). These fluorescent light pulses subsequently illuminate the photocathode of a photomultiplier that converts the light flashes into electrical pulses, which are integrated, amplified by an RC amplifier, and anlyzed by a multichannel pulse-height analyzer. The resulting histogram gives the distribution of the cellular fluorescent stain content over the cell population.

32941 **Digital data processing in surface testing.** Bodschwinna, H. (Technische Univ. Hannover (Germany, F.R.). Lehrstuhl und Inst. fuer Messtechnik im Maschinenbau). *VDI (Ver. Dtsch. Ing.) Ber.;* **6 p.**: No. 265, 47-52(1976). (In German).

From Technical meeting on industrial metrology; Stuttgart, Germany, F.R. (5 Oct 1976).

5 figs.; 6 refs.

True evaluation of technical surfaces is only possible to a very limited extent with the present state of research. Whereas the determination of generally used and standard roughness measures in given fabrication methods are sufficient for quality control at present in industrial manufacture, it is suggested that for research one should additionally determine microgeometrical characteristics of the surface profile sections by means of digital data aquisition and processing and evaluate according to statistical methods.

32942 **Penetration resistant barrier.** Hoover, W.R.; Mead, K.E.; Street, H.K. (to Energy Research and Development Administration). US Patent Application 657,518. 12 Feb 1976. 4p.

A barrier for safes, vaults and the like, and in particular, a barrier resistant to penetration by hand tools and cutting torches is described. The barrier comprises a layer of firebrick, which is preferably epoxy impregnated sandwiched between inner and outer layers of steel. Between the firebrick and steel are layers of resilient rubber-like filler.

32943 **Heat transfer characteristics of heat pipes.** Harada, K.; Inoue, S.; Fujita, J.; Suematsu, H.; Wakiyama, Y. *Hitachi Zosen Giho;* **37**: No. 3, 153-162(Sep 1976). (In Japanese).

The heat pipe, an excellent heat transfer element, is expected to become one of the most important elements in heat transfer techniques in the near future. Research on applying heat pipes to a waste heat recovery apparatus (gas-to-gas heat exchanger) is reported. To find low cost heat pipes having characteristics satisfactory for this purpose, heat transfer experiments were performed using several kinds of heat pipes which were commercially available from two companies in Japan, and others experimentally produced by us. The heat pipes produced by us are confirmed to be excellent for both low cost and performance.

32944 **Automatic box loader.** Eldridge, H.H.; Jones, R.A.; Lindner, G.M.; Hight, P.H. (to Energy Research and Development Administration). US Patent 3,981,406. 21 Sep 1976. Filed date 31 Oct 1975. 8p.

PAT-APPL-627-624.

A system for repetitively forming an assembly is described. The system consists of a single layer of tubes and a row of ferromagnetic armatures underlying the same, electromagnetically conveying the resulting assembly to a position overlying a storage box, and depositing the assembly in the box. The system includes means for simultaneously depositing a row of the armatures on the inclined surface of a tube retainer. Tubes then are rolled down the surface to form a single tube layer bridging the armatures. A magnet assembly carrying electromagnets respectively aligned with the armatures is advanced close to the tube layer, and in the course of this advance is angularly displaced to bring the pole pieces of the electromagnets into parallelism with the tube layer. The magnets then are energized to pick up the assembly. The loaded magnet assembly is retracted to a position overlying the box, and during this retraction is again displaced to bring the pole pieces of the electromagnets into a horizontal plane. Means are provided for inserting the loaded electromagnets in the box and then deenergizing the electromagnets to deposit the assembly therein. The system accomplishes the boxing of fragile tubes at relatively high rates. Because the tubes are boxed as separated uniform layers, subsequent unloading operations are facilitated.

32945 **Energy conversion device.** Sohre, J.S. US Patent 3,982,378. 28 Sep 1976. Filed date 13 Mar 1975. 10p.

A vortex tube construction in which the cold and hot fluids are recirculated to the inlet and energy is extracted from or added to the fluids either by heat exchange or by mechanical removal is described. This concept is adapted for other devices in which a flow of substantially homogeneous fluid is divided into separate flows at different energy levels.

32946 **Mechanical thermal motor.** Hein, L.A.; Myers, W.N. (to National Aeronautics and Space Administration). US Patent 3,987,630. 26 Oct 1976. Filed date 30 Jun 1975. 8p.

An apparatus is desribed for converting thermal energy such as solar energy into mechanical motion for driving fluid pumps and the like. The thermal motor comprises an inner concentric cylinder carried by a stationary core member having a cylindrical disc plate fixed adjacent a lower portion thereof and extending radially therefrom, and an outer concentric cylinder rotatably carried on the disc plate defining a space between the inner and outer concentric cylinders. A spiral tubular member encircles the inner concentric cylinder and is contained within the space between said inner and outer cylinders having a first portion connected to the inner concentric cylinder and a second portion connected to the outer concentric cylinder. A heated fluid is conveyed through the tubular member and is periodically cooled causing the tubular member to expand and contract, thus causing the outer concentric cylinder to reciprocally rotate on the base plate accordingly. The reciprocating motion of the outer concentric cylinder is then utilized to drive a pump member in a pump chamber.

32947 **Transformer for heat pipes.** Pessolano, R.L.; Rhodes, R.B. (to Isothermics, Inc.). US Patent 3,994,336. 30 Nov 1976. Filed date 13 Jun 1974. 6p.

The present invention comprises (1) a heat source, (2) a heat pipe, and (3) a thermal transformer in thermal contact with said heat pipe and proximately disposed to the heat source, whereby a uniform heat transfer from the heat source to a heating system is obtained. The thermal transformer includes (1) a container, (2) a working fluid and its vapor which are essentially in equilibrium, (3) evaporating surfaces depending from the internal surfaces of the transformer that are wetted with the working fluid and that are proximate to the heat source, and (4) condensing surfaces depending from the exterior of those areas of said heat pipe that are in thermal contact with said transformer.

32948 **Heat pipe fabrication.** Leinoff, S.; Edelstein, F.; Combs, W. (to Grumman Aerospace Corp.). US Patent 4,003,427. 18 Jan 1977. Filed date 15 Oct 1974. 4p.

A heat pipe is disclosed which is fabricated with an artery arranged so that the warp and weave of the wire mesh are at about a 45° angle with respect to the axis of the heat pipe.

32949 **Triple-point heat pump.** Cox, R.B. US Patent 4,003,213. 18 Jan 1977. Filed date 28 Nov 1975. 12p.

Heat pump systems are described that are useful for heating and cooling as well as for the production of potable water and in which the thermal energy employed is derived from heat liberated by the freezing of water under vacuum at the triple point.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 32300, 32304, 32305, 32306, 32307, 32308, 32784, 32827, 32855, 32858, 33034, 33035, 33036, 33037, 33038, 33039

32950 (AD—A029229) **Performance factors in rf SQUIDS - high frequency limit. Technical report.** Buhrman, R.A.; Jackel, L.D. (Cornell Univ., Ithaca, N.Y. (USA). School of Applied and Engineering Physics). 17 Aug 1976. Contract N00014-76-C-0526. 5p. NTIS (US Sales Only) $3.50.

The mode of operation of rf SQUIDs in the limit where the bias frequency Omega exceeds the natural R/L frequency of the SQUID ring is analyzed. Optimum coupling conditions are presented and the intrinsic noise limits are discussed.

32951 (AD—A030542) **Lasing tests with advanced reactants. Final report.** Cordill, J.D.; Clapp, S.D.; Forman, L.S. (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). Sep 1976. Contract N60921-75-C-0218. 89p. (R—9893). NTIS (US Sales Only) $5.00.

Results are presented of an experimental program conducted to evaluate the lasing characteristics of liquid and gaseous combustor reactants; combustor reactants evaluated included oxidizers (F_2, F_2-N_2 mixtures, NF_3), fuels (H_2, C_2H_4, C_6H_6(l), C6F6(l), $CH_{1.95}$(l)), and diluents(He, N_2, N_2O). Cavity fuel for all experiments was D_2. Lasing tests were conducted using two types of nozzles: a slit-type 2-D nozzle and a tri-stream 3-D nozzle. Closed-cavity power was measured at varying operational conditions. Results showed that: (1) advanced reaction combustion was efficient and carbon free, (2) hydrocarbon liquid and gas fuel lasing performance levels were similar, and (3) fluorocarbon fuel performed better than hydrocarbon fuel at high combustor temperatures (3000 K) and poorer than hydrocarbon fuel at lower combustor temperatures (1500 to 2500 K).

32952 (AD—A031942) **Magnetic flux annihilation in a large josephson junction. Technical summary report.** Scott, A.C. (Wisconsin Univ., Madison (USA). Mathematics Research Center). Jul 1976. Contract DAAG29-75-C-0024. 65p. (MRC-TSR—1649). Q 04/MF/A01.

Recent developments in the theory of the sine-Gordon equation are used to analyze the appearance of a displaced linear branch in the voltampere characteristic of a large Josephson junction. Internally the junction is divided into a flux annihilation domain near the center and flux flow domains near the edges. The displaced linear branch is experimental evidence for the existence of flux flow domains. In the flux annihilation domain, an ac voltage component is induced by the continuous formation and decay of sine-Gordon breathers. Whitham's nonlinear WKB method is used to analyze the flux flow domains while the inverse scattering transform method is used as a qualitative guide to the study of breather formation in the flux annihilation domain.

32953 (NTIS/PS—76/0744) **Josephson junctions (citations from the NTIS data base). Report for 1964—Aug 76.** Reimherr, G.E. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 150p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/590. See also NTIS/PS-76/0745, and NTIS/PS-76/0746.

The cited reports of Federally-funded research discuss the theory, design, fabrication, performance, and applications of Josephson junctions. References to such applications as far infrared radiation detectors, microwave detectors, voltage standards, noise thermometry and magnetometry are included. (This updated bibliography contains 143 abstracts, 32 of which are new entries to the previous edition.)

32954 (NTIS/PS—76/0745) **Josephson junctions. Volume 1. 1970-1974 (citations from the Engineerng Index data base). Report for 1970-74.** Reimherr, G.W. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 201p. NTIS (US Sales Only) $25.00.

See also NTIS/PS-76/0744.

The cited reports of worldwide research discuss the theory, design, fabrication, performance, and applications of Josephson junctions. References to such applications as logic circuits, shift registers, superconducting memories, far infrared detectors, microwave detectors, voltage standards, noise thermometry and magnetometry are included. (Contains 194 abstracts)

32955 (NTIS/PS—76/0746) **Josephson junctions. Volume 2. 1975-august 1976 (citations from the Engineering Index data base). Report for 1975-Aug 76.** Reimherr, G.W. (National Technical Information Service, Springfield, Va. (USA)). Sep 1976. 153p. NTIS (US Sales Only) $25.00.

See also NTIS/PS-76/0744.

The cited worldwide reports discuss research concerning the theory, design, fabrication, performance, and applications of Josephson junctions. References to such applications as logic circuits, shift registers, data storage devices, far infrared detectors, microwave detectors, voltage standards, noise thermometry, and magnetometry are included. (Contains 146 abstracts) See also NTIS/PS-76/0745, Josephson Junctions. Vol. 1. 1970-1974.

32956 (PB—257196) **Optical materials characterization. Semiannual technical report 1 Feb—31 Jul 76.** Feldman, A.; Horowitz, D.; Waxler, R.M.; Dodge, M.J. (National Bureau of Standards, Washington, D.C. (USA)). Aug 1976. 21p. (NBSIR—76-1115). NTIS (US Sales Only) $3.50.

See also report dated Feb 76, AD-A022 027.

Windows subjected to high-average-power laser radiation will undergo optical and mechanical distortion due to absorptive heating. If the distortion becomes sufficiently severe, the windows become unusable. Theoretical calculations of optical distortion in laser windows depend on the following material parameters; absorption coefficient, refractive index, change of index with temperature, thermal expansion coefficient, stress-optical constants, elastic compliances, specific heat, thermal conductivity and density. This program has been established to measure refractive indices, changes of index with temperature, stress-optical constants, elastic compliances, and thermal expansion coefficients of candidate laser window materials such as CaF_2, BaF_2 and ZnSe.

32957 Heat transfer to liquid helium in a narrow channel below 4.2 K. Kobayashi, H.; Yasukochi, K.; Tokuyama, K. (Nihon Univ., Tokyo). pp 306-309 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The heat transfer to liquid helium I and to liquid helium II in a cooling channel was examined as a function of geometry, bath temperature, and immersion depth. The channel simulates a cooling passage in a superconducting magnet. The measurements suggest that cooling with liquid helium II enhances the stability in the metastable operation of superconducting magnets both in the dc and in the pulsive mode.

32958 Supercritical helium cooled, cabled, superconducting hollow conductors for large high field magnets. Hoenig, M.O.; Iwasa, Y.; Montgomery, D.B.; Bejan, A. (Massachusetts Inst. of Tech., Cambridge). pp 310-313 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Within the last two years a new concept of cabled superconducting hollow conductors able to recover from transient instabilities by virtue of on-going, single-phase helium cooling was developed. It was possible to correlate small scale experimental results with an iterative computer program. The latter has been recently upgraded to include axial as well as radial heat transfer and predict more closely the chances of recovery. Nearly 1 g/s of supercritical helium was circulated in a closed loop using a high speed centrifugal fan and up to 10 g/s using a reciprocating single pulse bellows pump.The loop is being adapted to a 3 m length of a tightly wound 5000 A cabled hollow conductor equipped with pulse coils designed to fit inside a water cooled Bitter magnet. The combination will allow for a steady background field of 7.5 t with a 2 t superimposed pulse.

32959 New approach to the cooling of superconducting magnets for fusion reactors. Pasotti, G.; Spadoni, M. (Laboratori Nazionali del CNER, Frascati, Italy). pp 325-326 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A novel demand to study the feasibility of very large superconducting magnets comes from people working on controlled thermonuclear fusion. A reliable cooling system was investigated for the toroidal magnets of an experimental tokamak fusion reactor (FINTOR) currently under study in Italy. Most of the considerations can be applied to any large magnetic system.

32960 Experimental superconducting homopolar motors. Verkin, V.I.; Zhuchkov, M.I.; Shum, A.N.; Zinoviev, M.V.; Kurochkin, M.N.; Kolybaev, A.P.; Voskoboinik, A.P.; Danilenko, L.I.; Babenko, M.L. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 426-428 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Some designs of homopolar motors with superconducting field windings and their systems are considered and experimental data are given.

32961 Design and tests of liquid helium rotating cryostat. Brunet, Y.; Brac, G.F.; Gianese, P.; Pinet, C. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). pp 429-431 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The elaboration of a new cryogenic machine—a 500 kVA superconducting alternator of a new type—must begin with preliminary experiments to demonstrate its feasibility and to test special parts of the machine. This experimental apparatus was built to test the mechanical and cryogenic properties of a liquid helium rotating cryostat up to 3000 rpm. The key points studied have been the behavior of the insulation seals, the rotating seals, the thermal shield, the liquid helium supply and vapor recovery. Continuous information was obtained using a telemetry technique.

32962 Model rotor for the 6 MVA superconducting generator. Akiyama, S.; Fujino, H.; Ishihara, A.; Ueda, K.; Nishio, M.; Shindo, Y.; Fujii, H. (Fuji Electric Co., Ltd., Kanagawa, Japan). pp 432-434 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

A 6 MVA superconducting generator is being developed. As the first step, cooling technology was developed and confirmed for the rotor including superconducting field windings. The structure and the test results of the model rotor and the experimental results of the helium transfer coupling are described. The model rotor was cooled down to 4.2°K in 2.5 hours with consumption of liquid helium of 70 litres after precooling by liquid nitrogen. The field coils were energized to 416 amperes at the rate of 200 A/min. On liquid

helium transfer coupling the ferrofluidic sealing technique was applied. The experimental results were satisfactory and encouraged construction of the 6 MVA machine.

32963 Twenty-pole superconducting field winding. Boyer, L. (LGEP-LCIE, Fontenay-aux-Roses, France); Chabrerie, J.P.; Kordab, M.; Mailfert, A. pp 435-437 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The fabrication procedure and the test results of a twenty pole superconducting planar winding (thickness 3 cm, diameter 92 cm) are described. The materials used in constructing the winding are Nb—Ti multifilamentary composite and epoxy fiberglass composite. The test results indicate that the procedure used is quite suitable and might be applied for other multipolar inductors.

32964 Effect of the nature and structure of the matrix on losses in high current Nb—Ti multifilamentary composites. Fevrier, A.; Maldy, J.; Renard, J.C. (Laboratoires de Marcoussis, France). pp 461-463 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Losses were measured on 5T small coils, as a function of the amplitude and of the rate of increase of the magnetic induction, for several multifilamentary conductors. The conductors were composites of 10 μm Nb—Ti filaments in a two component (Cu—CuNi) matrix, twisted at the same pitch length and carrying about the same critical current. The conductors differed either in the arrangement of the components or in the nature of the surrounding layer. As expected, experimental results showed large loss decrease with the increase of CuNi content so that eddy currents were reduced. Besides, for high CuNi content additional losses take place for low values of the rate of increase of the magnetic induction. These results are analyzed with respect to present loss theories.

32965 Sources of instability in superconducting magnets and possible explanations of the training problem. Evans, D.; Colyer, B.F. (Rutherford Lab., Chilton, Eng.). pp 473-476 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The possible causes of 'training' in superconducting magnets are explored and related to operational experience gained from a range of solenoid and dipole magnets. The effect of the impregnant is briefly discussed and the possible interaction of this material with the conductor is considered.

32966 Training behaviour of pressure-impregnated superconducting racetrack magnets. Edwards, V.W.; Scott, C.A.; Wilson, M.N. (Rutherford Lab., Chilton, Eng.). pp 477-478 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Some small scale tests have been made with racetrack magnets as part of an investigation into the effects of impregnating windings with epoxy resin under pressure. The tests show that training is worse when the epoxy resin is pressurized. Advantage has been taken of the closed containment shell developed for these tests to try out weak materials such as propylene glycol (a liquid at room temperature) and paraffin wax. When used at atmospheric pressure the behavior of wax and epoxy resin is identical; neither shows training in this type of magnet.

32967 Report on the Basque superconducting solenoid project. Gallagher-Daggitt, G.; Wilson, M.N.; Micklewright, C.; Brown, J.; Dawson, J.; Roberts, R.; Daniel, R. (Rutherford Lab., Chilton, Eng.). pp 479-483 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The development, design, construction and evaluation of the Basque Superconducting Solenoid and its associated apparatus occupied a period of fifteen months. The work is described and the results obtained are discussed in the light of the criteria upon which it was based. It is also intended to include data of operational experience.

32968 Protection of the pulsed superconducting dipole ALEC. Kircher, F. (CEA/Saclay, Gif-sur-Yvette, France); Nithart, H.; Fevrier, A. pp 492-496 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Protection against excessive increase of temperature or electrical voltage across the winding becomes a problem with low-stabilized and large-stored energy superconducting magnets. Systematic theoretical and experimental studies have been carried out so as to define the accurate protection of the 'ALEC' project. The experimental results obtained with two small test coils are first reported and compared with theoretical ones using the classical propagation theory. The device used for the tests of the main coil and the measurements in relation with the protection are then summed up.

32969 Self field effect in round and rectangular multifilament composites and stability of superconducting coils. Turck, B. (CEN/Saclay, Gif-sur-Yvette, France). pp 497-500 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The self field effect is at the origin of unequal current distribution in composites. As a result the electric field can increase to high values which can lead to significant extra losses and instabilities. Measurements of this electric field show very good agreement with theoretical predictions. Noticeable reduction of the self field and improvement of stability are pointed out in rectangular composites. It is shown that stability depends highly on the rate of rise of the current.

32970 Quick methods of improving the field homogeneity of Atherton's type minimum volume superconducting coils. Echarri, A. (Universidad de Granada, Spain). pp 501-505 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

In 1969, Atherton studied the problem of minimum volume superconducting coils having a given Fabry factor, but with the superconducting current density inversely proportional to field. This is a feature common to all superconducting coils. Plots are presented of the second and fourth derivatives values, involved in the calculation of the field near the center of the coil, as a function of the coil parameters. Thus families of coils having identical values of the second and/or fourth derivatives can be easily found. Plots are presented for problems in which the internal bore of the superconducting magnet is given and those where the given parameter is the external radius of the magnet. The later plots are useful whereby a "best fitting, high field, cheap magnet" is required to enter inside a certain cryostat and allowances can be made for miniaturization of the measuring equipment and samples fitting within the internal radius of the magnet.

32971 Study of high voltage problems in a superconducting power pulse generator. Ulbricht, A.; Krauth, H.; Komarek, P. (Kernforschungszentrum, Karlsruhe, Ger.). pp 506-508 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

For realistic high voltage tests of magnets and their components at liquid helium temperature a pulse generator 'ESPE 2' was developed which consists of a s.c. coil shunted by a s.c. power switch. The maximal stored energy is 220 kJ and switching times of some tenth μ sec allow power pulses up to 62 MW at 50 kV. The main design ideas, the technical realization and the experimental test of the components are presented. The operation of the whole system was tested by generating first power pulses of 6 MW at 12 kV with a rise time of 14 μsec and a discharge time of 20 msec.

32972 Development of special envelope for cryogenic applications. Matsui, T. (Sumitomo Electric Industries Ltd., Osaka); Nagata, M.; Takagi, H. pp 509-511 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The heat inleak was measured through a multilayer superinsulation, a support and a joint using a rigid unit type envelope. After obtaining the above results, an ac 500 kV 10 GW superconducting cable was designed to compare the inleak with the conductor losses.

32973 Mechanical properties and the critical current in filamentary Nb_3Sn. Larbalestier, D.C.; Magraw, J.E.; Wilson, M.N. (Ruth-

erford Lab., Chilton, Eng.). pp 387-389 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Over the past two years a number of solenoids were made from filamentary (FM) Nb_3Sn conductor, some of which have operated at stress levels of approximately 150 MN/m^2. One of these, a 55 mm bore 11 Tesla peak field solenoid, has been extensively tested over 12 months, surviving some fifty quenches at or near peak field without showing any degradation of quench current. Even higher stress levels may be desirable if full advantage is to be taken of the high current densities possible in FM Nb_3Sn. Nb_3Sn is well known to be an extremely brittle material in bulk form, breaking at strains of approximately 0.2 percent. Determination of the stress and strain level to which FM Nb_3Sn conductors may be safely operated is an important piece of magnet design data. The details of a rig are described in which the fine details of the resistive transition of short samples of FM Nb_3Sn can be measured while tensile loads from zero to the rupture stress are applied. The preliminary results obtained with the rig show that irreversible degradation of the critical current does not occur until stress levels of greater than 250 MN/m^2 are reached.

32974 Composite superconductors. Howe, D.G. (to Secretary of the Navy). US Patent 3,989,475. 2 Nov 1976. Filed date 30 May 1975. 4p.

A composite superconductor is described which comprises (1) a first layer of an alloy selected from the group consisting of a vanadium-gallium (V—Ga) alloy with a gallium content from 12.5 at.% to 17.5 at.%, a niobium-tin alloy (Nb—Sn) with a tin content from 12 at.% to 17.5 at.%, and a vanadium-silicon (V—Si) alloy with a silicon content from 10.0 at.% to 20.0 at.%; (2) an intermediate layer of an A-15 compound selected from the group consisting of V_3Ga, Nb_3Sn, and V_3Si; (3) a third layer of an alloy selected from the group consisting of copper-gallium (Cu—Ga) alloy with a gallium content greater than 22 at.% but not greater than 30.0 at.%, a copper-tin (Cu—Sn) alloy with a tin content greater than 11 at.% but not greater than 21.0 at.%, and a copper-silicon (Cu—Si) alloy with a silicon content greater than 14 at.% but not greater than 21 at.%.

32975 Superconducting apparatus for converting microwaves into work. Dick, G.J. (to Secretary of the Navy). US Patent 3,995,433. 7 Dec 1976. Filed date 3 May 1976. 18p.

A superconducting microwave engine is described that achieves mechanical to microwave energy conversion or microwave to mechanical energy conversion. Such is accomplished by employing a superconducting resonator to increase the decay time of the microwaves inside the resonator and thereby provide the resonator with sufficient time to adiabatically deform and change its eigenfrequency so as to effect a change in the frequency and corresponding energy state of such microwaves in accordance with the Boltzmann-Ehrenfest Theorem. This invention may be in the form of a cylindrical cavity and piston combination, a cavity and vibrating diaphragm combination, or a cylindrical cavity and concentric rotor combination.

32976 Method for the manufacture of a superconductor having an intermetallic two element compound. Hauck, D.; Wilhelm, M. (to Siemens Aktiengesellschaft). US Patent 3,996,662. 14 Dec 1976. Priority date 20 Jun 1974, German, Federal Republic of (F.R. Germany). 8p.

A method of manufacturing a superconductor is described having a superconductive intermetallic compound of at least two elements in which a ductile component consisting of one element of the compound is brought into contact with a second component consistig of an alloy containing a ductile carrier metal and the remaining elements of the compound, after which the two components are subjected to a cross section reducing process and then heat treated such that the compound is formed through a reaction of the first component with the elements of the compound contained in the second component.

32977 Method for the manufacture of a superconductor having an intermetallic two element compound. Ziegler, G.; Lanig, P. (to Siemens Aktiengesellschaft). US Patent 3,996,661. 14 Dec 1976. Priority date 22 Jun 1973, German, Federal Republic of (F.R. Germany). 8p.

A method of manufacturing a superconductor is described having a superconductive intermetallic compound made of two elements and having an A-15 crystal structure in which at least one core consisting of a ductile element of the compound is surrounded with a jacket of an alloy containing a ductile carrier metal and the second element of the compound after which the jacket is then covered with a tantalum layer and that layer then covered with a sheath of metal which is electrically and thermally highly conductive and is electrically normally conducting at the operating temperature of the superconductor. The structure thus obtained is then subjected to a cross section-reducing deformation after which it is heat-treated to form the intermetallic compound.

32978 Multifilament superconductors. Howe, D.G. (to Secretary of the Navy). US Patent 4,002,504. 11 Jan 1977. Filed date 23 Dec 1975. 8p.

A multifilament composite superconductor is described which comprises (1) a matrix sheath selected from the group consisting of a copper-gallium (Cu—Ga) alloy with a gallium content from 0.4 to 22 at.% a copper-tin (Cu—Sn) alloy with a tin content from 1 to 11 at.%, and a copper-silicon (Cu—Si) alloy with a silicon content from 0.5 to 14 at.%; (2) multiple filaments embedded in said encasing matrix sheath and selected from the class consisting of a vanadium-gallium (V—Ga) alloy with a gallium content from 0.4 at.% to 12.5 at.%, a niobium-tin (Nb—Sn) alloy with a tin content from 0.1 at.% to 12.0 at.%, and vanadium-silicon (V—Si) alloy with a silicon content from 0.5 to 10 at.%; and (3) a continuous interfacial layer between said matrix and each filament of an A-15 compound selected from the class consisting of V_3Ga, Nb_3Sn, and V_3Si. A method is described for producing said multifilament composite superconductors by mechanical deformation of a multifilament coaxial cylinder consisting of filaments and matrix sheath which comprises a homogenization anneal of the filaments and the matrix rod before assembly thereof, a series of reductions followed by anneals, and a solid stage reaction between the filaments and matrix in vacuum or an inert atmosphere and at a temperature from about 475 to 700°C for the production of V_3Ga and V_3Si and at a temperature fromabout 525 to about 850°C for the production of Nb_3Sn.

32979 Process for the production of superconductor wires or cables of Nb_3Al and superconductor wires or cables obtained thereby. Ceresara, S.; Sacerdoti, G.; Sacchetti, N. US Patent 4,003,762. 18 Jan 1977. Priority date 22 Mar 1974, Italy. 6p.

A process for the production of superconductor wires or cables of Nb_3Al is described. The process consists in superimposing sheets of Nb to sheets of Al, inserting the superimposed sheets in a copper container, subjecting the copper container with the sheets contained therein to a plastic deformation processing so as to obtain a reduction in the thickness of the Al sheet to a value of less than about 1.5 μm, and finally subjecting this product to heat treatment at a temperature between 800 and 1000°C.

32980 Cryostat for accurate x-ray diffractometry of crystalline helium to 60 mK and 25 MPa. Heald, S.M.; Simmons, R.O. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Illinois 61801). *Rev. Sci. Instrum.;* **48**: No. 3, 316-319(Mar 1977).

A cryostat designed for accurate x-ray diffractometry of crystalline helium and other solidified gases is described and its performance characterized. The cryostat is a rigid tail design. It holds the crystal, grown at pressures up to 25 MPa, in fixed orientation and position independent of the levels of the cryogenic fluids. Such stability is necessary for crystal growth, orientation, characterization, and measurements of x-ray reflection intensities and x-ray scattering. A combination of beryllium and aluminized Mylar x-ray windows permits x-ray access to the specimen crystal over broad angular ranges, essentially 360degree in polar angle and +-40degree in inclination. At the same time, thermal radiation is small enough to permit temperatures as low as 60 mK to be achieved with a simple dilution refrigerator.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 32601

32981 Device for testing assault mask canisters for leakage of activated charcoal. Swope, L.G.; Schwab, R.J. (Goodyear Atomic Corp., Piketon, OH). *Am. Ind. Hyg. Assoc. J.;* 124-126(Feb 1976).

M-9 military assault masks effectively protect wearers from many hazardous industrial contaminants. However, M-11 canisters for these masks sometimes become faulty and leak activated charcoal into the inhaled air stream and into the eyes of the user. An inexpensive method of detecting such leakage so that faulty canisters can be identified and discarded is presented.

HANDLING EQUIPMENT AND PROCEDURES

32982 (CEA-CONF—3573) Two years of working experience for a $\beta\gamma$ laboratory dealing with plutonium base fuels. Peray, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Developpement des Elements Combustibles). 1976. 16p. (In French). NTIS (US Sales Only).

From 17. Meeting of the hot laboratory EURATOM Commission; Casaccia, Italy (25 May 1976).

The remarkable adaptation of the LECA (Laboratoire d'Examen des Combustibles Actifs, at Cadarache) for $\beta\gamma$ radiation work, allowed its use for UO_2, PuO_2 fuel testing to be envisaged. Results are presented for a two years experience. The facilities are

characterized by the a high efficiency dynamical tightness of the cells, the very elaborate partition of the zones with contamination risks, and the hierarchy in pressure suppressions. Due to improvements in air flows, intensification of controls, and thorough study of emergency techniques, the laboratory could obtain official appraisal for plutonium work.

SHIPPING CONTAINERS

32983 (SAND—76-0601) **Impact energy mitigation in LMFBR spent fuel shipping casks.** Weingarten, L.I. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract E(29-1)-789. 27p. Dep. NTIS $4.00.

Possible designs of LMFBR spent fuel shipping cask energy mitigators (impact limiters) with reference to what has been done in previous large shipping casks subject to the requirement arising from LMFBR spent fuel are discussed. (TFD)

TRANSPORT AND STORAGE FACILITIES

REFER ALSO TO CITATION(S) 31880

LASERS

REFER ALSO TO CITATION(S) 32172, 33052, 33356

32984 (AD—A029453) **Nonionizing radiation protection special study: exemption from new federal laser performance standards for tactical army laser systems and field training lasers.** Sliney, D.H.; Lyon, T.L. (Army Environmental Hygiene Agency, Aberdeen Proving Ground, Md. (USA)). Jul 1976. 22p. (USAEHA—42-303-76). NTIS (US Sales Only) $3.50.

A special study dealing with the requirements of an exemption from the new Federal laser performance standards on tactical Army laser systems was conducted by this Agency. It was determined that the exemption will have an immediate impact upon tactical lasers now in production. It was also evident that a military standard or specification would greatly aid in the implementation of the intent of the exemption to assure system safety features in tactical lasers.

32985 (AD—A030247) **Research in laser processes. Semiannual report 1 Feb—31 Jul 76.** Phelps, A.V.; Gallagher, A.C. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. (USA)). 31 Aug 1976. Contract N00014-76-C-0123,. 19p. NTIS (US Sales Only) $3.50.

Contents: Generation and Interpretation of Molecular Continuum Radiation; Stability of Discharges in Weakly Ionized Gases; Electron Excitation of Molecules; and Scattering and Transport of Resonance Radiation in Gases.

32986 (AD—A032139) **Information theory analysis of deactivation rates in chemical lasers. Final report.** Clendening, C.; Steinfield, J.I.; Wilson, L.E. (Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)). Oct 1976. 33p. (AFWL—TR—76-144). Q 03/MF/A01.

The Information-Theoretical method is used to synthesize a vibrational deactivation rate package for HF-HF collisions. The results give a good description of available experimental data, including the temperature dependence of the 1 to 0 rate. Other applications of theory which are considered, include rotational relaxation and a Populations' Evolution in Time solution to the master equation.

32987 (AD—A032301) **Gasdynamic effects on an electric discharge in air. Master's thesis.** Barto, J.L. (Naval Postgraduate School, Monterey, Calif. (USA)). Sep 1976. 145p. Q 07/MF/A01.

The overall purpose of the work described was to develop a subsonic, turbulent, diffuse electric discharge operating at near atmospheric pressure for use as the pumping mechanism in an Electric Discharge Convection Laser (EDCL). The work was done in two phases. The first consisted of a data collection phase during which the variation of discharge parameters was studied to determine their effects on the current-voltage characteristics of the multi-pin electrode arrangements used. The parameters studied included gap length, flow speed, turbulence intensity, electrode orientation, rate of voltage increase, and gas density through the addition of a diffuser. The second phase consisted of developing an interactive model which correctly reflects the dependences observed in phase one. A space-charge model resulted which correctly explains most major observed trends in gross discharge properties. Discharge stability is also discussed in terms of the model.

32988 (AD-A—026263) **Spectroscopy of fission fragment excited atmospheric pressure argon and xenon plasmas. Doctoral dissertation.** Davie, R.N. Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA)). 1975. 312p. (AFIT-CI—76-34). NTIS (US Sales Only).

Results of a spectroscopic investigation of atmospheric pressure Ar and Xe excited by fission fragments are reported. Spectra were taken at various distances from a planar fission fragment source, and a combined analytical and experimental absolute system calibration permitted estimation of excited state densities. The study was undertaken as part of an effort to develop new nuclear pumped laser systems, for which Ar and Xe are candidates. (GRA)

32989 (AD-A—026363) **Optical properties of europium-doped potassium chloride laser window materials. Interim technical report 1 May—31 Dec 1975.** Stoebe, T.G.; Spry, R.J.; Lewis, J.F. (Air Force Materials Lab., Wright-Patterson AFB, Ohio (USA)). Apr 1976. 31p. (AFML-TR—76-20). NTIS (US Sales Only).

Optical properties of samples from a large KCl:Eu crystal, produced by the Harshaw Chemical Company as part of the AFML laser window development program, have been investigated over a wide spectral region. Absorption bands due to Eu(++), which occur near 2400 and 3300 A in the ultraviolet, are used to monitor the Eu-ion content in the samples. The overall Eu(++) content varies throughout the sample according to the expected distribution of this ion during solidification, with the Eu(++) content increasing from cone to heel. An analytical relationship between absorption coefficient and concentration for Eu(++) is derived. Irradiation to 10 to the 8th power R is shown to modify the Eu(++) absorption spectrum, decreasing the Eu(++) absorption peak heights, and shifting the 2400 A band toward longer wavelengths. The latter may be due to the growth of a new band near 2700 A. Attempts to detect Eu(3+) in irradiated samples of in oxidized regions were successful, and the evidence indicates that Eu(3+) does not form in these samples. (Author) (GRA)

32990 (NTIS/PS—76/0613) **Dye lasers. Vol. I. 1964—1974 (a bibliography with abstracts). Report for 1964—1974.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Jul 1976. 153p. NTIS (US Sales Only).

Studies on design, tuning, optics, pumping, molecular energy levels and dye laser spectroscopy are presented. In addition reports on modulation, dyes, excitation, power output, stabilization and applications of dye lasers are cited. (This updated bibliography contains 148 abstracts, none of which are new entries to the previous edition). (GRA)

32991 (NTIS/PS—76/0614) **Dye lasers. Vol. II. 1975—June 1976 (a bibliography with abstracts). Report for 1975—Jun 1976.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Jul 1976. 104p. NTIS (US Sales Only).

Supersedes NTIS/PS—75/539, NTIS/PS—74/120, COM-73—11579, and NTIS-Pk—15.

The citations contain research documents on dye laser design, materials, pumping, tuning, frequency range, testing, modulation and excitation. Studies on dye laser use in laser isotope separation, optical communications and spectroscopy are included. (This updated bibliography contains 98 abstracts, 73 of which are new entries to the previous edition.) (GRA)

32992 (NTIS/PS—76/0993) **Ultraviolet and x-ray lasers (a bibliography with abstracts). Report for 1964—Oct 76.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Dec 1976. 192p. Q 01/MF/N01.

Supersedes NTIS/PS-75/738, and NTIS/PS-75/081.

The bibliography given is divided into two sections: Ultraviolet lasers and X-ray lasers. Their design, theory, diagnostics, and development are covered. Studies on new materials lasing in these wavelengths are also cited. (This updated bibliography contains 184 abstracts, 53 of which are new entries to the previous edition.)

32993 **Laser chain components (22 Mar 1976) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2426/1).

216 drawings.

Drawings are given of various components of LLL laser chains such as CYCLOPS, JANUS, and ARGUS. Details include connectors, supports, polarizer assemblies, junction boxes, amplifier bases, rectifiers, phase and reference controls, relay modules, SCR phase controls, reference and comparators, SCR drivers, power supplies, indicator panels, cable terminators, ground resistor boards, voltage dividers, circuit breaker panels, high voltage systems, current transformers, SCR heat sinks, and flashlamps. (PMA)

32994 **Ultra high power lasers: for practicable applications. Volume 76.** Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976). 164p. (CONF-760306—P2).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

Nineteen papers were presented at the conference. A separate abstract was prepared for each of seventeen papers. Papers on laser radar and rangefinder technology are not in scope for the data base. (MHR)

32995 **National laser-fusion program.** Hunsuck, J.D. (Energy Research and Development Administration, Washington, DC). pp 2-

6 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The National Laser-Fusion Program has grown into a maturing but still rapidly advancing major research and development program of the ERDA. The laser, once a solution looking for a problem has found a viable place in the pattern of search for solutions to energy and military problems. The program has grown from less than $1 million in 1963 to a projected total of $101 million in fiscal year 1977. Several existing advances have occurred and several milestones will be passed in the next two years. A projection of our program through the turn of the century is outlined. The hardest obstacles as we see them are presented.

32996 Status of large neodymium glass lasers. Glaze, J.A.; Simmons, W.W.; Hagen, W.F. (Lawrence Livermore Lab., CA). pp 7-14 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The elements of a Nd:Glass laser chain as it is constructed for fusion experiments are described. Also presented is a brief overview of the ARGUS and SHIVA systems.

32997 Damage limits for optical components exposed to nanosecond laser pulses. Bass, M. (Univ. of Southern California, Los Angeles). pp 15-21 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The mechanisms which cause a damaging interaction between laser light and optical materials are reviewed. Their dependence on laser pulse duration and wavelength is discussed and available experimental results for short pulse damage thresholds are presented. It is shown that localized absorption in coatings, surface defects, or impurity inclusions generally determines the practical irradiance limit. Intrinsic nonlinear processes such as avalanche breakdown or two photon absorption set the upper limit to the safe irradiance level. (MHR)

32998 High average power, rare-gas halogen-pumped iodine laser for fusion applications. Krupke, W.F.; George, E.V. (Univ. of California, Livermore). pp 22-29 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The rare-gas halogen and diatomic halogen molecular gases are relatively efficient, narrowband radiators in the ultraviolet spectral region when excited by electron beams. Production of 1.315 micron stimulated emission in atomic iodine was demonstrated recently by photolyzing C_3F_7I vapor with fluorescence emission from the XeBr exciplex. The use of spontaneous and superfluorescent emission from selected rare gas halogen exciplex systems to pump high average power atomic iodine lasers for fusion applications is explored with emphasis on the pump source kinetics in relation to amplifier design.

32999 High power atomic iodine photodissociation lasers. Palmer, R.E.; Padrick, T.D.; Jones, E.D. (Sandia Labs., Albuquerque, NM). pp 32-38 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The atomic iodine photodissociation laser has developed into a system capable of producing nanosecond or shorter pulses of near infrared radiation with energies well in excess of a hundred joules. Discussed are the operating characteristics, advantages, and potential problem areas associated with this laser.

33000 Generation and amplification of nanosecond duration multiline HF laser pulses. Getzinger, R.W.; Ware, K.D.; Carpenter, J.P. (Univ. of California, Los Alamos). pp 39-43 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

High-power, fast-rising pulses of hydrogen fluoride laser energy suitable for laser-fusion target interaction experiments can in principle be generated by directing an electro-optically shuttered oscillator pulse through one or more electron-beam driven amplifiers. A three-stage HF master oscillator-power amplifier (MOPA) configuration was constructed and tested successfully using SF_6—C_2H_6 in which an E-O generated 4-ns-FWHM pulse was amplified in an electron-beam-excited third stage and subsequently isolated with a Brewster angle splitter. Independent experiments in which a 100-ns-FWHM pilot pulse interacted with the power amplifier demonstrated for the first time complete extraction of the available laser energy. These two results provide strong evidence that with upgrading to H_2—F_2, it should be possible to obtain nanosecond duration pulses with power levels sufficient for meaningful laser fusion target coupling experiments.

33001 High energy HF pulsed lasers. Patterson, E.L.; Gerber, R.A. (Sandia Labs., Albuquerque, NM). pp 44-50 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

Recent experiments show that pulsed HF lasers are capable of producing high energy with good efficiency. Preliminary experiments show that the laser radiation from the high-gain medium can be controlled with a low-power probe laser beam or with low-level feedback. These results indicate that the HF laser may have potential for second-generation laser fusion experiments.

33002 Deuterium fluoride cw chemical lasers. Wilson, L.E. (Air Force Weapons Lab., Firtland AFB, NM). pp 51-58 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The current performance and understanding of deuterium fluoride (DF) cw chemical lasers are summarized. The fundamental principles of the laser are explained. The advantages and disadvantages of the laser system are discussed. The characteristics of the DF laser beam, the performance parameters and operating characteristics are enumerated.

33003 High power CO lasers: what, how, when, and where?. Mann, M.M. (Northrop Research and Tech. Center, Hawthorne, CA). pp 59-67 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (Ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The characteristics of high power electric discharge CO lasers are reviewed with emphasis on the unique properties which differentiate CO EDL's from competitive systems. The operational principles and design constraints are discussed. The results of investigations into some of the most promising approaches to the development of high power devices are summarized. Projections for device performance and technology development are presented. Consideration is given to the impact that the potential advantages of the CO EDL may have in enhancing the performance and/or simplifying the design of laser systems for practical applications.

33004 Assessment of the electron beam and discharge technologies for high pressure gas laser pumping in terms of kinetics and electrical design. Hunter, R.O.; Oldenettel, J.R. (Maxwell Labs., San Diego, CA). pp 68-76 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (Ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

Kinetics of electron beam pumped and electron beam controlled discharge pumped lasers are discussed. Device scaling criteria are given for window foil survival, electron beam pinching, electron beam pulse length, discharge pulse length, and discharge-electron beam interaction.

33005 Combustion driven gas dynamic CO_2 lasers. Gerry, E.T. (W. J. Schafer Associates, Inc., Arlington, VA). pp 91-97 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (Ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The basic principles behind the operation of the thermally pumped C_2 gas dynamic laser are developed. Experimentally demonstrated performance is compared to theoretical upper limits and approaches for performance improvement toward these limits are reviewed. Relative efficiency and utility vis-a-vis electrically pumped CO_2 lasers are discussed. Investigations towards a thermally pumped laser based on the HCl molecule are reported.

33006 High-power electric discharge lasers. Reilly, J.P. (Avco Everett Research Lab., Everett, MA). pp 98-110 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

CO_2 electric discharge lasers have proven themselves to be efficient sources of high power, high quality laser output energy. The basic concepts behind molecular gas discharge lasers are described concentrating on the CO_2 system. A summary of the three classes of electric laser systems is presented as well as examples of operating devices in each class.

33007 Performance of DF/CO_2 transfer lasers. Solomon, W.C.; Driscoll, R.J.; Furner, T.E.; Zelazny, S.W. (Bell Aerospace Div, of Textron Inc., Buffalo). pp 111-121 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

The transfer chemical laser has been shown to provide efficient performance under three modes of operation. Specific powers as great as 47 kj/lb and pressure recovery potential up to 0.6 atmospheres have been achieved. The potential development of the device has been directed towards short chain operation.

33008 Review of uv excimer lasers. Ewing, J.J. (Avco Everett Research Lab., Everett, MA). pp 132-143 of In Ultra high power lasers: for practicable applications. Vol. 76. Wilson, L. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1976).

From SPIE/SPSE technical symposium; Reston, Virginia, United States of America (USA) (22 Mar 1976).

See CONF-760306—P2.

A brief review of recent research in novel UV lasers is given. Special emphasis is placed on these lasers which have recently shown potential for high efficiency. A new class of lasers, the rare gas monohalides, is reviewed in detail. A kinetically complementary set of lasers operating on halogen molecules is discussed since these species have demonstrated very high fluorescence efficiencies.

33009 Competition effects and single-mode unidirectional laser action in a solid-state ring laser with time-varying cavity. Kravtsov, N.V.; Shelaev, A.N. (Scientific-Research Institute of Nuclear Physics, M. V. Lomonosov Moscow State University). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 198-199(Jun 1976).

The first results are presented of an experimental study of a solid-state laser with a cavity whose parameters are functions of time. Self-modulation modes are described. (AIP)

33010 Chemically pumped solid-state laser. Styrov, V.V. (S. M. Kirov Tomsk Polytechnical Institute). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 211-212(Jun 1976).

The possibility of using heterogeneous chemiluminescence as a method of pumping solid-state lasers is considered. (AIP)

33011 Strontium- and calcium-vapor recombination lasers. Zhukov, V.V.; Kucherov, V.S.; Latush, E.L.; Sem, M.F.; Tolmachev, G.N. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 215-216(Jun 1976).

Experiments were performed that demonstrate the high efficiency of vapor lasers based on SrII and CaII transitions. (AIP)

33012 Pulsed CO_2-air laser with externally produced discharge. Kozlov, G.I.; Korablev, A.S. (Institute of Problems of Mechanics, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 7, 230-232(Jul 1976).

The development of an electrode arrangement and an electronic circuit for exciting high energy discharge in a CO_2-air mixture is reported. (AIP)

33013 Double heterostructure stripe geometry semiconductor laser device. Yonezu, H. (to Nippon Electric Co., Ltd.). US Patent 3,993,964. 23 Nov 1976. Filed date 18 Aug 1975. 6p.

A semiconductor laser device includes a narrow elongated semiconductor region of the same conductivity type as another semiconductor region lying in the vicinity of the active region of the laser device. The elongated region extends in depth from the surface of the device to the vicinity of the active region. A surface semiconductor layer of an opposite conductivity type covers the entire surface of the device except for the elongated region.

33014 Folded cavity injection laser. Blum, J.M.; Lean, E.G.H.; McGroddy, J.C. (to International Business Machines Corp.). US Patent 3,996,528. 7 Dec 1976. Filed date 31 Dec 1975. 6p.

An injection laser, which is chemically etched to provide mirror-like surfaces, also is provided with a chirped diffraction grating. The latter grating, which is etched in the injection laser, combines with the chemically etched sides to provide laser emission in a direction substantially parallel to the current flowing through the laser. As an alternative to the chirped diffraction grating, waveguides are included in the resulting folded cavity laser. Either of the above structures relaxes the fabrication tolerance in the inclined surfaces etched in the laser relative to known folded cavity lasing structures. 7 claims, 6 drawing figures.

33015 Internally referenced, laser intracavity technique for measuring small gains or losses. Pilloff, H.S. (to Secretary of the Navy). US Patent 3,995,957. 7 Dec 1976. Filed date 16 Oct 1975. 4p.

A method and system for measuring small gain or losses in a laser cavity are described. The method includes placing a sample in a cell in a two beam system in which one beam polarized in one direction passes through the cell while the other beam of different polarization does not pass through the cell. The ratio of the two polarizations with the sample in and out of the cell in the system determines a measure of the effect of the sample on the system. The ratios are measured with the sample cell empty and then with the sample in the cell.

33016 Acousto-optically tuned laser. Hughes, R.S.; Imbert, M.P.; Nowicki, T.F. (to Secretary of the Navy). US Patent 3,996,525. 7 Dec 1976. Filed date 12 May 1975. 4p.

A tunable laser is described wherein the tuning element is intracavity and comprises a polarizing prism for linearly polarizing the beam, and an electronically tunable filter backed by a retroreflective surface.

33017 Chromium-doped beryllium aluminate lasers. Morris, R.C.; Cline, C.F. (to Allied Chemical Corp.). US Patent 3,997,853. 14 Dec 1976. Filed date 29 Nov 1974. 6p.

Single crystals of chromium-doped beryllium aluminate find advantageous use in optical applications and, in particular, in lasers capable of operating at room temperature.

33018 Optical convertor for laser systems. Gillman, J.J.; Ropp, R.C. (to Allied Chemical Corp.). US Patent 3,999,145. 21 Dec 1976. Filed date 7 Apr 1975. 10p.

A crystalline optical convertor, adapted to improve the efficiency of a resonant cavity of a laser cavity system, includes: neodymium ions used as lasing ions, a host for the neodymium ions which is used as a laser rod, convertor ions, and a crystalline convertor host. The convertor ions are selected from the group consisting of trivalent dysprosium and trivalent samarium. The crystalline convertor host is selected from the group consisting of: yttrium orthovanadate, yttrium phosphate, yttrium arsenate, yttrium chromate, gadolinium orthovanadate, gadolinium phosphate, gadolinium arsenate, gadolinium chromate and combinations thereof in solid solution. The convertor ions act as an activator for the crystalline convertor host. The combination of neodymium ions and neodymium host is arranged separate from the combination of the convertor ions and the convertor host. The optical convertor is used to convert input electromagnetic radiation not readily absorbed by the neodymium ions to a wavelength which approximately matches the excitation wavelength of the neodymium ions.

33019 Recirculation or stirred reactor flow laser. Osgerby, I.T. (to Secretary of the Air Force). US Patent 4,000,477. 28 Dec 1976. Filed date 13 Feb 1974. 4p.

A laser which obtains lasing action from gases flowing into and out of a laser cavity is substantially improved by causing the flowing gases to traverse a strongly recirculating flow field. The recirculation of exhaust flow gases into the incoming flow gases, in a controlled recirculation region, leads to substantially uniform distribution of gas composition, chemical and thermodynamic states, pressure, temperature, density and refractive index throughout the cavity. Recirculation flow fields are generated by opposed jets, behind baffles, in swirling flow, in spheres when jet velocities are high and in duct flows where a high momentum, high velocity jet is surrounded by a co-flowing low momentum low velocity stream.

33020 Dielectric active medium for lasers. Yamada, T.; Otsuka, K.; Suzuki, H.; Nakano, J.I. (to Nippon Telegraph and Telephone Public Corp.). US Patent 4,000,247. 28 Dec 1976. Priority date 27 May 1974, Japan. 10p.

A single crystal essentially consists of XM/sub z/M'/sub 1-z/P_4O_{12}, (0 less than Z less than or equal to 1) in which X is lithium and/or sodium, M is neodymium, and M' is yttrium, lanthanum or gadolinium. Said single crystal can be used as a dielectric active

medium for lasers, and can be prepared in the form of a bar having a square cross section measuring 5 mm on each side by the top-seeded solution growth methods.

33021 Beam addressed liquid crystal cells. Sprokel, G.J. (to International Business Machines Corp.). US Patent 3,999,838. 28 Dec 1976. Filed date 5 Jun 1975. 8p.

A beam addressed liquid crystal cell having an absorbing layer adapted to absorb energy in the infrared spectrum while transmitting substantial energy in the visible spectrum is disclosed. In a preferred embodiment the absorbing layer contains the reaction product of bis(dithiobenzil) nickel and a polyamide. This absorbing layer absorbs at least 90 percent of the gallium arsenide laser wavelengths and at the same time permits transmission in the visible spectrum to be of the order of 80 percent.

33022 Non-photographic, digital laser image recording. Becker, C.H.; Wong, H.; Kaspari, W.J. (to Precision Instrument Co.). US Patent 4,001,840. 4 Jan 1977. Filed date 7 Oct 1974. 14p.

A non-photographic, digital laser image recording and reading method and apparatus for recording and reading visual, two-dimensional replicas or representations of objects, pictures, illustrations, computer outputs and the like are described. A flat-field twon objective is employed to project the image of a laser beam focused to a diffraction limited spot on a radiation sensitive material, e.g., a heat ablatable or vaporizable recording medium to create a two-dimensional ensemble of holes in the recording medium. The recording medium comprises thin metallic films carried on flat substrates which are moving at constant speed or are immovably held while the image of the diffraction limited spot is scanned thereover by angularly deflecting the laser beam entering the twin objective. The visual laser record is an instantaneous replica of an original image or its computer processed binary equivalent.

33023 Hermetically-sealed injection semiconductor laser device. Yonezu, H.; Hayashi, I. (to Nippon Selfoc Co., Ltd.). US Patent 4,003,074. 11 Jan 1977. Priority date 3 Dec 1973, Japan. 10p.

A hermetically sealed injection semiconductor laser device includes a hollow cylinder in which a crystal laser pellet is enclosed. The ends of the cylinder are sealed by metal electrodes one of which projects axially into the cylinder and is connected to an electrode surface of the crystal pellet. A lens element is disposed within the cylinder.

33024 Suppressing superradiance. Mallozzi, P.J.; Epstein, H.M.; Applebaum, D.C.; Gallagher, W.J.; Campbell, B.E. (to Battelle Memorial Inst.). US Patent 4,002,403. 11 Jan 1977. Filed date 11 Oct 1973. 10p.

Methods and apparatus are described for directing a radiation pulse from a laser to a target for other selected location and preventing undesired earlier radiation from the laser, having less than a selected intensity from reaching the selected location. A beam splitter directs a major portion of the radiation pulse energy along a longer main path to a predetermined region and continuing on toward the selected location, and directs a minor portion along a shorter secondary path to the predetermined region. A reflective surface on a transparent support in the predetermined region prevents energy having less than the selected intensity from continuing on toward the selected location. The surface comprises a thin layer, as of aluminum, that remains substantially unimpaired until it is subjected to radiation having at least the selected intensity, and then is substantially removed in the area impinged by such radiation, so that when the minor portion of the radiation pulse energy along the shorter secondary path has at least the selected intensity, and thus substantially removes the impinged area of the reflective layer, the major portion of the radiation pulse reaching the predetermined region thereafter can continue on through the area of removal toward the selected location. Alternatively, the minor energy portion actuates an electrical discharge to vaporize the reflective layer at least substantially. 24 claims, 2 figures.

33025 Method of melting laser glass compositions. Spanoudis, L. (to Owens-Illinois, Inc.). US Patent 4,002,449. 11 Jan 1977. Filed date 21 May 1975. 8p.

A method is disclosed for melting laser glass compositions that includes double melting steps as follows: melting the glass composition in a ceramic container in an oxidizing atmosphere in which the partial pressure of oxygen is greater than about 10^{-3} atmospheres; and melting the resultant melt in a platinum container containing at least about 50 percent by weight of platinum in a reducing atmosphere in a buffered gas mixture in which the partial pressure of oxygen is less than about 10^{-3} atmospheres for a time sufficient to obtain a homogenization of the glass with stirring and still having the ingredients of the glass composition in an oxidized state to thereby produce a laser article substantially free from detrimental, lower-valence state ingredients, such as Fe^{++}, and a minimum of platinum inclusions in the glass. The method may also include double steps as follows: providing a premelted glass laser composition in a highly-oxidized state in which the ingredients are highly oxidized; and thereafter melting the highly-oxidized glass of Step I as above indicated in a reducing atmosphere in a buffered gas mixture in a platinum container for a time sufficient to provide a homogenized glass and still have the glass composition ingredients in a highly oxidized state. 13 claims.

33026 Laser action by optically depumping lower states. Krupke, W.F. (to Energy Research and Development Administration). US Patent 4,004,250. 18 Jan 1977. Filed date 26 Nov 1975. 10p.

A method and apparatus are described for obtaining laser action between an upper energy level and a lower energy level of a gaseous medium, which comprises populating the upper energy level to some degree (short of achieving a conventional inverted population) by any suitable pumping means, and thereafter establishing an inverted population by transiently and selectively depumping the lower energy level such as by exposing the medium to an intense source of radiation which selectively causes the transformation of the lower energy level species to some other energy level. Thus, a thermally pumped/optically depumped gas laser system is produced.

33027 Pulsed gas laser with low-inductance flow-through electrodes. Levatter, J.I.; Lin, S.C. (to Xonics, Inc.). US Patent 4,005,374. 25 Jan 1977. Filed date 31 Mar 1975. 8p.

An electrically pumped gas laser is described with an electrode assembly providing for gas flow through spaced upstream and downstream electrode arrays with the flow path perpendicular to the optical axis of the laser in a very low inductance electrical circuit. Electrode arrays are comprised of parallel spaced blade shaped electrodes, with the upstream electrodes having a contoured leading edge and a trailing knife edge spaced from the walls of the discharge space, and with the downstream electrodes having a leading knife edge spaced from the walls of the discharge space and a similarly contoured trailing edge. An electrode assembly includes upstream and downstream gas flow channels providing a double parallel plate transmission line for electrical connections and energy storage, with the channel walls serving either directly or as supporting structures for the inner plates, and with the outer plates in the form of conducting sheets spaced from the inner plates by insulating sheets.

33028 Apparatus for increasing output efficiency of an optically pumped ND:YAG laser. Nichols, R.W. (to Hughes Aircraft Co.). US Patent 4,005,333. 25 Jan 1977. Filed date 3 Jun 1974. 4p.

Laser excitation is generally initiated by "dumping" energy from a stored supply into a flashlamp. The flashlamp produces light which is a mixture of both blackbody type radiation and atomic line spectra. That portion of the flashlamp output energy spectrum which overlaps the pump bands of Nd^{3+} uses the inversion population necessary for laser action. It has been determined that the sequence in which energy is initially supplied to the flashlamp is an important parameter. More particularly, light output in the pump bands, and hence laser efficiency, is increased by slightly turning on the flashlamp at a predetermined interval of time prior to the main energy dump. Theory indicates that this method of triggering results in a larger ionic path diameter at the time of main energy release to the flashlamp.

33029 Dynamics of multilevel laser excitation: Three-level atoms. Shore, B.W.; Ackerhalt, J. (University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Phys. Rev., A;* **15**: No. 4, 1640-1647(Apr 1977).

We display the time dependence of populations in coherently excited three-level atoms. In particular we examine the relationship between ion production and the dynamical parameters: Rabi frequencies, detunings, and loss rate.

33030 New method for the determination of luminescence lifetimes by using the beat noise of a cw laser as a multifrequency-modulated source. Hieftje, G.M.; Haugen, G.R.; Ramsey, J.M. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Appl. Phys. Lett.;* **30**: No. 9, 463-466(1 May 1977).

The excitation of a fluorophore by rapidly varying fluctuations in a free-running argon-ion laser is shown to produce variations in measured fluorescence. The power spectrum of the fluctuations can yield lifetime information on luminescence and the experimental apparatus described exploits this phenomenon. Methods of improving the measurements are also considered.

33031 Hollow-cathode aluminum ion laser. Gerstenberger, D.C.; Reid, R.D.; Collins, G.J. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). *Appl. Phys. Lett.;* **30**: No. 9, 466-468(1 May 1977).

We have observed five laser transitions in the 358—747-nm region, all of which originate from excited energy levels of singly ionized aluminum. Laser action was obtained by exciting a neon buffer gas in an aluminum hollow cathode and the excitation mechanism is thought to be a Ne^{+}-Al charge transfer reaction. Single-line output power on the 358-nm laser transition of Al II was 9 mW, while multiline infrared output was 5 mW.

33032 Variations in the transition probabilities and quantum efficiency of Nd^{3+} ions in ED-2 laser glass. Brecher, C.; Riseberg, L.A.; Weber, M.J. (GTE Laboratories, Inc., Waltham, Massachusetts 02154). *Appl. Phys. Lett.;* 30: No. 9, 475-478(1 May 1977).

Radiative and nonradiative transition probabilities from the $^4F_{3/2}$ state of Nd^{3+} in ED-2 laser glass were measured for ions in different sites using laser-induced fluorescence line-narrowing techniques. Both radiative and multiphonon transition probabilities were found to be site dependent, with the relative radiative quantum efficiency varying by as much as 50%.

33033 Complete compensation of self-phase modulation in cesium vapor at 1.06 μ. Lehmberg, R.H.; Reintjes, J.; Eckardt, R.C. (Naval Research Laboratory, Washington, D.C. 20375). *Appl. Phys. Lett.;* 30: No. 9, 487-489(1 May 1977).

We have observed a complete cancellation of self-phase modulation in 1.06-μ pulses propagating through cesium vapor. The negative nonlinear refractive index responsible for this is measured as $n_2/N = -(2.5 \pm 0.5) \times 10^{-30}$ esu, in good agreement with the theoretical value -2.62×10^{-30} esu.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 32306, 32319, 32379, 32430, 32511, 32517, 32670, 32914, 32943, 32947

33034 Pool boiling heat transfer to cryogenic liquids. Verkin, B.I.; Kirichenko, Y.A.; Dolgoy, M.L.; Levchenko, N.M.; Tsybulsky, V.V. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 286-288 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The results on vapor bubble dynamics, heat transfer coefficients and first critical heat flux, which were studied in the process of cryogenic liquid boiling in a wide range of pressures, are presented. Formulas are proposed, which give a satisfactory generalization of the experimental results.

33035 Heat transfer in helium-1. Verkin, B.I.; Kirichenko, Y.A.; Kozlov, S.M.; Levchenko, N.M. (Physical-Technical Inst. of Low Temperatures, Kharkov). pp 289-291 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Experimental heat transfer coefficients for nucleate pool boiling of helium at 1 to 2 bar, critical heat fluxes q/sub max/, and temperature drops ΔT/sub max/ are presented. The q/sub max/ and ΔT/sub max/ values are theoretically interpreted in terms of a thermal model of departure from nucleate boiling. The dependences are derived for heat transfer coefficients on temperature averaged over the volume in the supercritical region up to 4.9 bar and T = 7 K.

33036 Heat transfer for evaporating nitrogen streaming in a horizontal tube. Klein, G. (Deutsche Forschungs-und Versuchsanstalt fur Lugt-und Raumfahrt eV., Cologne). pp 314-318 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The local heat transfer for nitrogen evaporating in a horizontal tube was experimentally investigated in the convective and in the nucleate boiling region as a function of heat flux, quality, and mass flow density. All the measurements were carried out at a boiling pressure of 3.0 bar. The resulting flow pattern of the two phase flow could be observed and photographed in an unheated sight tube which followed the heated test section. The experimental values for the local heat transfer coefficient were compared with equations known from literature; the values could be correlated with satisfactory accuracy by means of dimensionless equations.

33037 Experiments on helium refrigerant at high speed of rotation. Haseler, L.E.; Ball, A.; Scurlock, R.G. pp 414-417 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

Electrical machines with superconducting field windings can require helium refrigeration in a rotating system. Heat transfer measurements have been made on helium in a rotating open thermosyphon. Various heater surfaces have been used at the end of a 25 mm tube full of helium at a radial distance of 0.22 mm from the rotation axis for speeds up to 37 Hz, for both boiling heat transfer in subcritical helium, and convective heat transfer in sub and supercritical helium. A larger rotor of 0.44 m radius, to rotate up to 60 Hz, has been constructed to extend the range of the experiments.

33038 Thermally induced convection of helium in a rotating frame. Hofmann, A. (Univ., Karlsruhe, Ger.). pp 418-420 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The convection rate of superconducting helium circulating in a rotating thermosyphon loop is calculated. The one-dimensioned analysis takes account of the variation of the helium properties by application of fundamental thermo-dynamic relationships. The results are applied to a large size rotating magnet for a synchronous generator. It is shown that the steady losses caused by thermal insulation leakage and by conduction through the mechanical support together with the enhanced centrifugal forces can induce a steady helium flow in the coolant ducts. Only a rather small heat flow is necessary to induce such a helium flow which proves to be sufficient for forced cooled magnets.

33039 Solution of the steady-state and transient behaviour of a rotating, helium-filled thermosiphon loop. Thornton, G.K. (Oxford Univ.). pp 421-425 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The thermosiphon loop is proposed as a means of distributing helium coolant within the field windings and rotor of a superconducting alternator. Numerical solutions of a one-dimensional thermosiphon model are presented which consider both the steady-state operation with constant heat loads and the response of the system to transient heat loads. The solution of the steady-state case shows that for a given heat input to the loop the mass flow rate of coolant is controlled by the friction losses in the system. The time-dependent solution provides a characteristic response time for the thermosiphon when it is subjected to an additional heat load.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 32375

33040 (BDX—613-1174(Rev.)) Reflected light intensity distributions from defects on highly reflective spheres. Klingsporn, P.E. (Bendix Corp., Kansas City, Mo. (USA)). Feb 1977. Contract EY-76-C-04-0613. 45p. Dep. NTIS $4.00.

A light reflection technique suitable for development into an automated surface quality certification system was investigated to determine if reflected light intensity distributions could be correlated with surface defect depths. Reflected laser light intensity distributions from pit and scratch defects on highly reflective spheres were studied with a commercial multi-element photodetector. It was found that the intensity distributions could be correlated with depths of pits and scratches in a size range of concern on highly reflective spheres.

33041 (BDX—613-1363(Rev.)) Angular distribution of diffuse light reflected from isolated defects on superfinished spheres. Klingsporn, P.E. (Bendix Corp., Kansas City, Mo. (USA)). Feb 1977. Contract EY-76-C-04-0613. 27p. Dep. NTIS $4.00.

A special array of light pipes was constructed and used with a photodetector to measure the angular distribution of light reflected diffusely from small isolated defects on superfinished nickel spheres. Defects in a size range of concern were detected by the system, and angular distributions of the diffuse light generated by the defects correlated with the defect dimensions. At present, a commercial version of the light sensing array used in this study is not available; however, under development is a more desirable optical system for automated surface certification which will use a photodetector array which is available commercially.

33042 (BDX—613-1497) Optical system for automated inspection of highly reflective spherical surfaces. Klingsporn, P.E. (Bendix Corp., Kansas City, Mo. (USA)). Feb 1977. Contract EY-76-C-04-0613. 68p. Dep. NTIS $4.50.

An optical system was designed for use in automated inspection of superfinished spherical surfaces. Helium neon laser light is used to illuminate a small region on the spherical surface, and the light reflected from the surface is focused to a point on the face of a photodetector array capable of measuring light intensity as a function of both radial and angular coordinates. When an isolated defect such as a pit or scratch is illuminated, a characteristic diffraction

pattern, centered about the focused spot, is observed in the plane of the detector array. Theoretical relations were derived which relate the intensities and sizes of the defect diffraction patterns to the type and dimensions of the isolated defect. The latter relations are important for determining defect sizes from photodetector measurements of the diffraction pattern intensities and thereby establishing surface quality certification criteria.

33043 (NTIS/PS—76/0780) **Nondestructive testing: x-ray photography and radiography (citations from the ntis data base). Report for 1964-Aug 76.** Reed, W.E. (National Technical Information Service, Springfield, Va. (USA)). Oct 1976. 153p. NTIS (US Sales Only) $25.00.

Supersedes NTIS/PS-75/666. See also NTIS/PS-76/0781.

Federally-sponsored research and foreign reports covering techniques, equipment, and applications are cited. Applications include flaw detection, fatigue determination, inspection of joints, and measurement of mechanical and physical properties. (This updated bibliography contains 153 abstracts, 28 of which are new entries to the previous edition.) (GRA)

33044 (NTIS/PS—76/0781) **Nondestructive testing: x-ray photography and radiography (citations from the engineering index data base). Report for 1970-Jul 76.** Reed, W.E. (National Technical Information Service, Springfield, Va. (USA)). Oct 1976. 215p. NTIS $25.00.

See also NTIS/PS-76/0780.

The bibliography cites reports from worldwide research covering techniques, equipment, and applications. Applications include flaw detection, fatigue determination, inspection of joints, quality control, and measurement of mechanical and physical properties. (Contains 208 abstracts) (GRA)

33045 (SAND—76-5547, pp 289-302) **Computer reconstruction of pseudoholograms obtained from a fission gamma source.** Hessel, K.R.; Stalker, K.T. (Sandia Labs., Albuquerque, NM). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

Pseudoholograms obtained with a Fresnel zone plate coded aperture have been reconstructed using digital computer techniques. The object was a ^{252}Cf fission gamma source. The digital reconstruction procedure and its advantages relative to analog techniques is discussed. Image reconstructions indicate transverse and longitudinal resolutions on the order of millimeters. Several digital enhancement options are available. Plans for improved results are discussed.

33046 **Underwater radiographic apparatus.** English, P.N. US Patent 3,993,906. 23 Nov 1976. Filed date 25 Jun 1975. 10p.

An inflatable bag is inserted through a small orifice in the side wall of a submerged, liquid-containing hollow member to be radiographed. The inflatable bag is directed to a chosen location within the hollow member, where it is inflated, displacing the liquid from the chosen location. A penetrating radiation source is securely positioned externally on the side wall of the hollow member so that penetrating radiation emanating from the source will traverse the chosen location within the hollow member. Imaging means is securely positioned externally on the side wall of the hollow member so that the chosen location within the hollow member is between the penetrating radiation source and the imaging means. After the radiograph has been made, the inflated bag is deflated and withdrawn from the orifice, following which the orifice is sealed, and the penetrating radiation source and imaging means are removed from the hollow member.

33047 **Fourier model for ultrasonic frequency analysis.** Simpson, W.A. Jr. (Oak Ridge National Lab., TN). *Mater. Eval.;* **34**: No. 12, 261-264, 274(Dec 1976).

Fourier transform techniques are applied to the interpretation of ultrasonic frequency analysis, yielding results in basic agreement with previous interference models, but capable of explaining anomalies unaccounted for by such models. In addition, the present approach indicates that both attentuation and phase-shift measurements may be obtained directly from the displayed spectrum, either separately or simultaneously.

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 31852, 33192

VACUUM ENGINEERING

33048 **Sputter-ion pump having improved cooling and improved magnetic circuitry.** Welch, K.M. (to Varian Associates). US Patent 3,994,625. 30 Nov 1976. Filed date 18 Feb 1975. 6p.

In a magnetically confined sputter-ion vacuum pump a multi-apertured anode electrode is interposed between a pair of reactive cathode electrode plates. An evacuable envelope encloses the anode and cathode electrodes and a magnetic circuit surrounds the vacuum envelope for producing a glow discharge confining magnetic field extending axially of the apertures in the anode. The reactive cathode plates include peripheral sealing flanges for compressing a sealing gasket into sealing engagement with a pair of sealing surfaces at opposite ends of a tubular main body portion of the envelope. A clamping ring structure, having a bolt circle formed therein, serves to clamp the two reactive cathode plates to the main body and also serves as an integral part of the magnetic circuit. Water coolant channels are brazed to the outer surfaces of the cathode plates for cooling same in use. The magnetic circuit includes a pair of ferrite magnets disposed outside the envelope on opposite sides of the cathodes and enclosed by a magnetic yoke to minimize the size and weight of the magnet and to reduce unwanted stray magnetic fields.

33049 **Thermal processing and encapsulation of solids in metal tubulations.** Kayser, F.X.; Stowe, G.L. (Ames Laboratory ERDA and Department of Materials Science and Engineering, Iowa State University, Ames, Iowa 50011). *J. Vac. Sci. Technol.;* **14**: No. 2, 747-748(Mar 1977).

A vacuum processing technique is described that permits encapsulation of the sample in metal tubing by application of a cold-weld pinch-off. It is particularly useful for annealing samples of materials that are capable of gettering glass surfaces. The hardware involved are standard commerical items.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 32301, 33096

33050 (UCID—17391) **IC inspection test masks: experimental results.** Ciarlo, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Feb 1977. Contract W-7405-ENG-48. 63p. Dep. NTIS $4.50.

Integrated circuit inspection test photomasks were scanned with four automated inspection systems to determine if these masks could be used to test and calibrate automated inspection systems. It was found that the dimensions on the background die pattern of such masks must be accurate before an automated system, especially a scanning type, can be used to inspect them. A stepping accuracy better than +-20 μin. and preferably better than +-10 μin. is required. When adjustments were made for the stepping error by the operator, an automated system found nearly twice as many defective die as were found during a manual inspection of the same mask. The fabrication of inspection test masks by the insertion of intentionally defective reticles into an otherwise perfect array suffers from the inability to accurately position the inserts. A better way to achieve randomly positioned defects would be to make them with a laser scribing machine and with chrome patching. Randomly positioned defects are desired if an automated inspection system is to be compared with a manual scan technique. If all that is desired is the calibration of the automated system, then the defects can be positioned in a regular manner but there must be a large number of them in a variety of sizes so that detection statistics can be accumulated.

33051 **Transistorized dual beam raster oscilloscope (6 Jan 1971) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2559).

92 drawings.

Drawings are given for a transistorized dual beam raster oscilloscope. Details include the schematic, change page, intensifier and vertical sweep, vertical trigger and lock-out, timing generator, horizontal sweep board, timing generator, grid pulser, timing generator (externally triggered) and sync. (PMA)

33052 **Faraday rotator (25 Feb 1976) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2428/1).

8 drawings.

The Faraday Rotator 5 kV Capacitor Bank is a pulsed output power supply used to energize Faraday rotators for optical isolation in the LLL kJ Glass Laser System. Each supply contains either one, two or three parallel 240 μF storage capacitors depending on the size of the isolator used. All models of isolators were tested with four capacitors under maximum voltage and 25 feet of RG-217 cable with no hazardous effects. Except for the number of capacitors in each unit, the supplies are otherwise physically identical. Drawings are given of the rotator mount and base, tie bar, cable plate, table plate, removable cover, and rotator coil.

33053 **One- and two-species equilibria for magnetic insulation in coaxial geometry.** Bergeron, K.D. (Plasma Theory Division, Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Fluids;* **20**: No. 4, 688-697(Apr 1977).

A cold-fluid, self-consistent model of electron and ion flow in coaxial cylindrical geometries is applied to the problem of magnetically insulated diodes. The one species, nonrelativistic problem is studied to determine in what configurations and parameter domains equilibria corresponding to magnetic insulation exist. It is proved that when the outer electrode is the cathode, equilibria always exist. For an inner cathode, whether or not equilibria exist and whether they are unique depends on whether the field is azimuthal or longitudinal and on the ratio of the radii. The two-species relativistic problem is then analyzed with the help of a computational routine which integrates the cold-fluid differential equations and searches the parameter space for the point corresponding to space charge limited emission. As the critical field is approached from above, the resulting values of ion current show an enhancement over the single species prediction by a factor which increases with voltage and with anode radius. Patterns of nonexistence of equilibria similar to those observed for the one-species, nonrelativistic case are also found.

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

33054 Computer control of the refuse incinerator. Part II. Mori, H.; Ohba, K.; Kawahara, M.; Adachi, R.; Shirouzu, Y.; Haruna, K.; Ozawa, K.; Teramoto, K. *Hitachi Zosen Giho;* **37**: No. 3, 123-128(Sep 1976). (In Japanese).

For the automatic operation of the refuse incinerator, quantitative data on the combustion conditions are necessary. The combustion conditions were determined by measuring various process values using new instruments. After various control experiments practical automatic combustion control was achieved using a computer. In the tests the thickness of the refuse layer was estimated by calculation, using the driving torque of the grate cutter and the differential pressure of the refuse layer, and the central position of combustion was estimated by using the grate temperature and the gas temperature over the grate. Experiments on the control system were carried out continuously for one week each at the rated load and 75 percent load of the incinerator. These results meet or even exceed those of skilled operators.

33055 Combustion furnace construction particularly a refuse incinerator. Kuenstler, H. US Patent 4,006,693. 8 Feb 1977. Priority date 30 Nov 1972, Switzerland. 6p.

A combustion furnace particularly for refuse incineration is described which comprises furnace walls which enclose a fire chamber having a grate extending across at least a part of the fire chamber of the furnace. The furnace walls have a portion adjacent the grate which comprises inner and outer spaced metal walls with a hollow space between said walls. A metal shield plate is spaced inwardly from said inner furnace wall and extends around at least a substantial portion of the periphery of the grate which is adjacent the furnace walls and there is an intermediate hollow space between the shield plate and the inner furnace wall. The inner metal furnace wall has openings communicating with the hollow space between the inner and the outer furnace walls and the shield plate has openings communicating with the intermediate hollow space between the shield plate and the inner furnace wall with the fire chamber. Means are provided for supplying air into the hollow space between the inner and outer furnace walls which flows through the openings of the inner wall and the shield and also through the openings of the shield to the furnace chamber so that it both aids in the combustion and in cooling the metal shield plate and the furnace walls.

COMBUSTION SYSTEMS

33056 Jet impingement heating. Hemsath, K.H.; Vereecke, F.J. (Midland-Ross Corp., Toledo). pp 21p., Session III, Paper 4 of In Proceedings of the third conference on natural gas research and technology. White, J.W. (ed.). Chicago, IL; Institute of Gas Technology (1974).

From 3. conference on natural gas research and technology; Dallas, Texas, United States of America (USA) (6 Mar 1974). See CONF-740387—.

High speed heating of metals to forming temperatures offers many advantages in terms of product quality and process control. To obtain high heating rates at conventional forming temperatures, the amount of heat transferred by convection must be increased. The design of a machine for high speed heating must therefore be closely related to convection heat transfer requirements. A study of convection coefficients of impinging jets has defined the optimum shape and location of jets for application in a high speed heating machine. The design and operating characteristics of the machine are described and initial test results are discussed.

33057 Energy saving device. Long, L.M. US Patent 3,987,785. 26 Oct 1976. Filed date 21 Mar 1975. 4p.

The device is a baffle array that is housed in a section of pipe that coupled from an oil burner to a chimney. The baffle array, when closed, blocks about 70% of the pipe cross-sectional area and opens upon the occurrence of a small explosion when the oil burner starts to permit this explosive puff to pass to the chimney. The baffle array includes three baffle plates, each pivoting at its top end and all interconnected at the bottom end.

33058 Horizontal vent air terminal for sealed combustion furnaces. Winters, M.E.; Proctor, P.E. (to Coleman Co., Inc.). US Patent 3,994,280. 30 Nov 1976. Filed date 26 Feb 1975. 10p.

An air terminal for a horizontal vent of a sealed combustion furnace includes a faceplate for mounting to an exterior vertical wall. A horizontal flue pipe extension, receiving the combustion products, is surrounded by an oval sleeve. Fresh air is communicated to the furnace through the space between the flue pipe and the sleeve. The outlet of the flue pipe is at least about 3/4 in. outside the faceplate. An enlarged fresh air intake opening exists about the flue pipe, and a pocket-shaped rain shield is located beneath the flue pipe extending upwardly and inwardly. A horizontal wind deflector vane is located beneath the flue pipe and extends across the width of the fresh air intake opening for directing incident wind downwardly along the wall. The terminal improves operation of the furnace under all wind conditions, whether the furnace is operating on pilot or main burner modes.

33059 Compressed oil burner starting mechanism. Graffman, J.H. (to Clean Air Company, Inc.). US Patent 4,007,000. 8 Feb 1977. Priority date 3 Nov 1972, Sweden. 4p.

A compressed oil burner is described which includes an operating nozzle having a valve body which is yieldingly loaded against a valve seat in a direction opposite to the flow direction so that fuel is supplied at a pulsating pressure, a sleeve surrounding the operating nozzle with adjustable dampers for supplying air thereto and check valves for exhausting fuel and air mixtures, a separate starting nozzle having an air fuel mixing chamber with outflow apertures positioned on the sleeve in front of the operating nozzle and fuel and air inlets into the chamber to supply fuel and air thereto when the fuel supply to the operating nozzle is closed.

33060 Heat power plant. McAleer, W.J. US Patent 4,008,991. 22 Feb 1977. Filed date 20 Oct 1975. 6p.

A power plant for producing heat is described. A frame is rotatably mounted within a container with an inertia wheel mounted to and rotatable with the frame. A fuel storage tank mounted within the frame is connected between and to an external source of fuel and a plurality of fuel injectors mounted to the inertia wheel. Cooling means within the container cover the frame and at least a portion of the inertia wheel with a combustion chamber provided within the container above the cooling means. Igniting means mounted to the container projects into the combustion chamber and is operable to ignite fuel intermittently injected into the combustion chamber by the injectors mounted to the inertia wheel. Pumping means provided on the frame is operable to pump fuel from the storage tank to the injectors in a timed relationship to the position of the injectors relative to the cooling means and combustion chamber. Heat is withdrawn from the container resulting from the combustion of the fuel. 8 claims, 2 figures.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 31772, 31852, 33116

33061 (UCRL—52166) **Using cross-borehole electromagnetic probing to locate a tunnel.** Lytle, R.J.; Lager, D.L.; Laine, E.F.; Davis, D.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Oct 1976. Contract W-7405-ENG-48. 45p. Dep. NTIS $4.00.

Theoretical and experimental studies of electromagnetic interaction with a tunnel found that signal minima can be used to detect and locate the tunnel. These minima are found on the transmission side of the tunnel, the side opposite the signal transmitter. From the appearance of the signal and comparison with Fresnel diffraction, the main mechanism of signal interaction with the tunnel seems to be diffraction rather than refraction or reflection. Experiments were made around a tunnel near Gold Hill, Colorado. The tunnel was horizontally and vertically located within three feet.

33062 In situ leaching of explosively fractured ore bodies. Coursen, D.L. US Patent 3,999,803. 28 Dec 1976. Filed date 23 Dec 1974. 18p.

A method for producing a fracture network in deep rock, e.g., in an ore body, by detonating explosive charges sequentially in separate cavities therein, the detonations producing a cluster of overlapping fracture zones and each detonation occurring after liquid has entered the fracture zones produced by previous adjacent detonations is claimed. High permeability is maintained in an explo-

sively fractured segment of rock by flushing the fractured rock with liquid, i.e., by sweeping liquid through the fracture zones with high-pressure gas, between sequential detonations so as to entrain and remove fines. Ore bodies prepared by the blast/flush process with the blasting carried out in substantially vertical, optionally chambered, drilled shot holes can be leached in situ via a number of holes previously used as injection holes in the flushing procedure and a number of holes which are preserved upper portions of the shot holes used in the detonation process. In the leaching of ore, fines are removed from fractures by intermittent or continuous flushing of the ore with lixiviant and high-pressure gas, e.g., air, using, in the case of the in situ leaching of an explosively fractured ore body, a lateral and upward flow of lixiviant from zones that have been less severely, to others that have been most severely, worked by multiple detonations in the ore body. 8 claims, 4 drawing figures.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 31790, 31791, 31801, 31824, 31825, 31826, 31827, 31828, 31830, 31831, 31832, 31833, 31834, 31835, 31882, 31885, 32822, 33289

33063 Explosion suppression systems for marine applications. Richards, R.C.; Sheehan, D. pp 429-436 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Coast Guard Research and Development Center tests of two explosion suppression systems conducted in the forward pump room (18,000 cu ft) of the T/V RHODE ISLAND are described. The experimental suppression systems were specifically designed for the space and fabricated from existing hardware and detection equipment. They are the first systems to effectively extinguish propane-air explosions in volumes as large as 18,000 cu ft. The effectiveness of water, Halon 2402, Halon 1211, Halon 1301, and Purple K dry chemical powder as suppressing agents was evaluated. The systems were being evaluated to determine their applicability in pump rooms and other high hazard spaces on tank vessels. They could also be used in offshore-well drilling operations in spaces where gas buildup might occur, such as wellheads, storage tanks, and production platforms. The testing demonstrated that technically it is feasible to suppress explosions generated by rapid oxidation of vapor/air mixtures in large volumes. For the various extinguishing agents, the tests indicated that successful suppression requires twice as much water as Halon and approximately 10 times as much Halon as dry chemical (Purple K) by volume. The results of the work will be used as a basis in establishing criteria for evaluating explosion suppression systems that may be submitted to the Coast Guard for approval.

33064 Use of propellant-actuated anchors in underwater construction. Taylor, R.J.; True, D.G. pp 430-445 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Three propellant anchors have been developed at the Navy's Civil Engineering Laboratory (CEL), the CEL 10K, 20K, and 100K anchors. These anchors, their operational characteristics, test results, and potential uses are described. Actual uses of these anchors also are detailed. The 10K anchor has been designed recently and has only been tested on land to define gun performance and in shallow water to verify ocean operability. The 20K anchor has been thoroughly tested in different seafloors in water depths from 50 to 18,600 ft. Its use in CEL's SEACON II experimental cabled structure, in an amphibious operation, and its use at Midway and future use at Barking Sands to taut moor Navy ships performing construction operations that require limited ship movement are described. Two four-point spread tanker moorings were installed at Diego Garcia in a coral seafloor using the CEL 100K anchor. Eighteen anchors were used; two load-equalized anchors at each of four points for the "temporary" POL facility and two each at three points with four anchors at the fourth (turning) point for the "permanent" POL facility.

33065 Self-burying anchor of considerable holding power. Kerr, N. pp 447-478 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Developed recently at the National Engineering Laboratory, Scotland, the Hydropin anchor buries itself deep in the seabed by fluidizing and pumping. 1, 2 and 4 ft diameter Hydropins have been buried 20 to 30 ft, in sand, in the Moray Firth (NE Scotland). Average burial rates were 1 ft per minute. Because it derives its resistance to pull-out from the overlying soil, the Hydropin is an extremely strong anchor. The 4 ft diameter version weighed 1000 lb and was buried 25 ft. A pull of 80 US tonf failed to move it.

33066 In-line and transverse forces on cylinders in oscillatory flow at high Reynolds numbers. Sarpkaya, T. (Naval Postgraduate School, Monterey, CA). pp 95-108 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper presents the results of an extensive experimental investigation of the in-line and transverse forces acting on smooth and rough circular cylinders placed in oscillatory flow at Reynolds numbers up to 700,000, Keulegan-Carpenter numbers up to 150, and relative roughnesses from 0.002 to 0.02. The drag and inertia coefficients has been determined through the use of the Fourier analysis and the least squares method. The transverse force (lift) has been analyzed in terms of its maximum, semi peak-to-peak, and root-mean-square values. In addition, the frequency of vortex shedding and the Strouhal number has been determined. The results have shown that (a) for smooth cylinders, all of the coefficients cited above are functions of the Reynolds and Keulegan and Carpenter numbers, particularly for Reynolds numbers larger than about 20,000; (b) for rough cylinders, the force coefficients also depend on the relative roughness k/D and differ significantly from those corresponding to the smooth cylinder; and that (c) the use of the "frequency parameter," $D^2/\nu T$ and the roughness Reynolds number, U/sub m/k/ν allows a new interpretation of the present as well as the previously obtained data and the establishment of model laws for oscillatory flow about cylinders at supercritical Reynolds numbers.

33067 Wave interaction with a submerged open-bottom structure. Chakrabarti, S.K.; Naftzger, R.A. (Chicago Bridge and Iron Co., Oak Brook, IL). pp 109-123 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The interaction of sinusoidal waves with a large open bottom structure near the ocean floor is investigated. The wave diffraction problem is formulated within the framework of linearized potential theory and solved numerically on a digital computer. The analysis is confirmed by the results of wave tank tests on a hemispherical shell and underwater storage tank models. It is found that both the horizontal and vertical forces acting on an open structure are lower than those on the corresponding sealed structure, the vertical force, in particular, being an order of magnitude smaller over the practical range of wave periods. The inside pressure on the structure when slightly open correlates very well with the mean bottom pressure on the structure when sealed, so that the results for the slightly open case can be obtained from the results for the sealed case.

33068 Forces on a cylinder oscillating sinusoidally in water. II. Further experiments. Dalton, C. (Univ. of Houston, TX); Hunt, J.P.; Hussain, A.K.M.F. pp 159-167 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper deals with wave forces on a single cylinder. The wave forces are simulated in a laboratory by oscillating a cylinder sinusoidally in water otherwise at rest. This effort is a parametric study relating a force coefficient to such variables as instantaneous Reynolds number, period parameter, and d/rootνT. The force is not decomposed into drag and inertia components, but is represented as a continuous function of the previously mentioned parameters. The idea is to determine how the acceleration affects the force. Considerable deviation from a Reynolds-number only dependence is noted for low Reynolds numbers. The steady-flow drag coefficient value is asymptotically obtained for large Reynolds numbers.

33069 Forces on a large vertical cylinder in multi-directional random waves. Huntington, S.M.; Thompson, D.M. (Hydraulics Research Station, Wallingford, Eng.). pp 169-183 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The linear diffraction theory used for calculating pressures, forces and moments on large structures in regular long crested waves is extended to short crested multi-directional random waves and applied to the case of a large surface piercing cylinder. Computer calculated theoretical results are compared with the results of

measurements on a cylinder in laboratory generated short crested seas. Comparisons between theory and experiment were made in terms of transfer functions, calculated in the latter case from the measured spectra of the waves, pressures, forces and moments. The linearity of the experimental results and their agreement with theory even in severe sea states show that the theory can be used for design purposes.

33070 Effects of current on dynamic response of offshore platforms. Wu, S.C. pp 185-196 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The stochastic dynamic responses of offshore platforms, with and without the presence of current, are studied and discussed. The formulation derived in the paper can be used to determine the statistics of platform response with proper consideration of the nonlinear effect caused by current. The phenomenon of wave-current interactions is known to change wave characteristics; its effect on structural responses is also examined. Five deepwater platforms are analyzed under different wind wave and current loading conditions. Numerical results showing the effect of current, the contribution of current when the wind waves become stronger, and the effect of wave-current interactions on the dynamic response are presented.

33071 Study on characteristics of world-first floating city Aquapolis. Hoshino, M.; Ishida, M.; Ninomiya, K.; Nishitani, H. pp 197-213 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The "Aquapolis" is an exhibit of the Japanese Government at the world's first International Ocean Exposition, held in Okinawa in 1975, in accordance with the International Exposition Treaty. During the 6-month period from July 20, 1975 till January 18, 1976, it was attacked by typhoons 14 times. In putting the Aquapolis on display at the Exposition, the Japanese Government sought for a structure capable of maintaining a high degree of safety as a floating city at the typhoon-ridden island, free of natural environment pollution, and befitting the theme of the Exposition. As a result, it was concluded that a semi-submerged closed-system marine structure would be most suitable. In this paper, we report on the results of various kinds of model tests conducted in designing the marine structure and the results of sea trials performed after its completion. During the Exposition period, we gathered as much data as possible on sea and weather conditions and on the oscillation of the Aquapolis.

33072 Use of wave-maze flexible floating breakwater to protect offshore structures and landings. Noble, H.M. pp 215-224 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The Wave-Maze floating breakwater is a patented process for building a flexible floating breakwater. The basic component of this breakwater consists of used truck tires, some of which are filled with materials such as polystyrene or polyurethane, to provide flotation. The assembly of the breakwater and the results of model tests are reported. (JSR)

33073 Review of developments and problems in using floating breakwaters. Adee B.H. pp 225-236 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

In this review the basic types of floating breakwaters are examined. Data on a number of current installations and their construction costs are included. Materials used in construction are discussed in the light of present applications and problems that have been encountered. The field performance and measured mooring forces are presented for breakwaters that have been instrumented. The conclusion is that current installations are effective in reducing the incident-wave energy. However, their performance is closely tied to the incident-wave frequency. As experience with these structures is accumulated, their use in increasingly severe environments can be expected.

33074 Prototype performance characteristics of two floating breakwaters. Christensen, D.R.; Richey, E.P. pp 237-252 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The performance characteristics of floating breakwaters, i.e., the transmission coefficients, anchor forces, and accelerations in heave, roll, and sway, are evaluated from field measurements on a concrete modular type installed at two different locations in Alaska, and a pontoon-type installed at a location in the State of Washington. In all three instances, the installations served to protect small boat harbors from local, wind generated waves. The measurements were planned with the combined purpose of evaluating the breakwater types under different wave exposures and to supply basic data for the verification and development of a theoretical predictive model for breakwater performance. The instrumentation system was designed with multiple-channel, digital recording capability and packaged for use in remote locations, requiring only periodic maintenanc checks and tape changes. The system can be set to be activated by any selected wind speed and sample the various input sensors at prescribed intervals and durations of time. A systematic design procedure for floating breakwaters needs to be developed so the potential of the concepts can be utilized more completely. The data on the full scale prototype systems can be used, in conjunction with laboratory findings, to calibrate and otherwise contribute to the development of the predictive models. The instrument package design can be adapted to respond to a wide variety of sensors and installation constraints.

33075 Tethered float breakwater: a temporary wave protection system for open ocean construction. Seymour, R.J. pp 253-264 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Marine construction costs are strongly influenced by the local wave climate. Some of the effects of the use of a transportable breakwater on these costs are examined. The tethered float breakwater, a transportable ocean based system under development by a Federal/State consortium, is described and the current program status reviewed. Representative incident and transmitted wave climates are selected and the factors leading to hardware design choices to meet these requirements are presented. The resultant breakwater design is described and a range of operating costs is projected for a commercial wave abatement service. Typical offshore construction applications are illustrated. A program for commercial development of a tethered float breakwater for marine construction is suggested.

33076 Design of an artificial island for industrial purposes in the North Sea. Stuiver, M.; Steyn, B. pp 265-282 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The study regarding the feasibility of an artificial industrial island has basically been made to gain an impression about the economic consequences of establishing industrial activities upon this island, particularly as compared with identical mainland activities. To this end a procedure has been developed to select potential island users engaged in activities, complementary to operations already existing on the nearby mainland. The design of an island, intended to facilitate the potential users, was made and the environmental impact of the island with industrial occupants was assessed. Of great interest is the document containing the conclusions respecting the legality of island construction in the high seas and especially on the Dutch continental shelf. The conclusions were that basically there are no legal objections to creating artificial islands in the high seas. The overall conclusion is that the construction of such an artificial island for industrial purposes is feasible.

33077 Slow motions of tankers moored to single point mooring systems. Wichers, J.E.W. pp 283-303 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

It is known that in steady current and wind in combination with irregular waves a tanker will not take up a steady position in the horizontal plane. Both full scale observations and model tests have shown that the behavior of a tanker moored to a single point mooring system is greatly determined by the slow motions of the tanker in the horizontal plane. Due to these slow motions (fish-tailing and galloping) of the tanker, high loads can occur in the bow hawser. In order to be able to solve the general SPM mooring problem of the slowly varying drifting behavior of the object moored by means of a bow hawser, it is apparent that first a number of fundamental aspects will have to be studied separately. In this paper the results of a study on the dynamic stability and the natural frequencies of the modes of motions of the tanker in the horizontal

plane, including the effect of the system parameters in steady current and wind will be presented. A procedure will be shown to obtain practical values of added mass and damping to calculate the nature of the stability and the natural frequencies of the system. To have insight in the sensitivity of the various system parameters on the stability and the natural frequencies, results of calculations will be shown. Trends following from the calculations are compared with results of model tests. The results of the tests and the calculations show a reasonable agreement.

33078 Structural integrity monitoring using digital processing of vibration signals. Begg, R.D. (Univ. of Glasgow, Eng.); Mackenzie, A.C.; Dodds, C.J.; Loland, O. pp 305-311 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper has dealt with the theoretical ideas and assumptions from which structural monitoring using vibration analysis has been developed. From these considerations it can be seen clearly that the method is founded on principles and ideas which are already well-established in other fields. Although troublesome, the effect of the pile nonlinearity is being overcome and the remaining doubts are in the domain of practicability.

33079 Experiences in developing and operating integrity monitoring systems in the North Sea. Loland, O.; Dodds, C.J. pp 313-319 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Offshore structures vibrate under the action of the sea, wind, and on board machinery. The response is most marked at the natural frequencies of these structures which are dependent on the geometry, stiffness, and mass of the structure and are independent of the excitation. Measurements of the responses of three platforms in the North Sea have been made over a period of nine months. Each platform has produced a unique signature which has remained constant within prescribed limits. Failure of any structural member in the platform will produce a change in the signature and changes of greater than 15 percent have been measured when minor modifications were made to one of the test platforms. This vibration analysis technique for the monitoring of offshore structures as a primary inspection aid is both technically feasible and practically possible.

33080 Machinery vibration on offshore platforms. Monk, R.G. pp 321-331 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

It is generally accepted that machine failures can be prevented by regular monitoring of machine vibration levels. Such benefits are highly desirable for offshore production platforms, and the paper presents details of recent field experience which shows quantitatively that regular monitoring not only reduces equipment failure, but that it also increases equipment reliability. The paper also presents some preliminary vibration data for 1st generation North Sea platform equipment, which demonstrates the value of checking vibromechanical conditions onshore before equipment is installed in the complex dynamic environment of the platform.

33081 Offshore platforms: observed behavior and comparisons with theory. Ruhl, J.A. pp 333-352 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The measured static and dynamic response characteristics of four jacket-type platforms in water depths up to 373 feet are described. Fundamental periods and damping were determined both by free vibration tests and spectral analysis of random response data. For each platform, measured end-on and broad-side natural periods were nearly equal with values ranging from 1.5 to 1.9 seconds; the theoretically predicted natural period for one of these platforms was close to the measured value. Damping estimates range from approximately 1.0 to 5.0 percent of critical depending on the methods of testing and data analysis. For one platform spectra of both deck motions and wave heights are presented; measured amplitudes of response are compared to theoretical predictions. Motions predicted using regular Airy wave theory overestimate the measured motions for the tested platforms and the low sea states considered.

33082 Offshore platform displacement with an inertial reference system. Schmidt, T.R. pp 353-361 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Platform displacement measurements are useful in evaluating analytical techniques, basic assumptions, and conditions related to platform dynamics. Light portable equipment using an inertial reference to measure platform motion is described. Amplitudes in the range of a few thousandths of an inch to a foot or more over a frequency band of one twentieth of a Hertz to several Hertz can be measured. Examples of calibration runs and actual platform tests are given. Methods of presenting data are illustrated including strip chart recording, horizontal plane platform motion plots, displacement spectrum plots and extended time multiple spectra plots.

33083 Dynamic behavior and design of offshore caissons. Hong, S.T.; Brooks, J.C. pp 363-373 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Free-standing caissons are used for supporting flare pipes and single well production platforms. However, caissons tend to be flexible and dynamically sensitive, and the static design practice may not be adequate for this type of structure. In order to assess the motion effect on the integrity of the structural system and to quantify the allowable motion for safe operation on board a caisson platform, analytical and experimental studies of the dynamic behavior of a caisson structure have been conducted and are described in this paper. The analytical simulations check well with the motion measurements in a statistical sense. A caisson design procedure considering dynamic effects has been developed. Design considerations include ultimate strength failure, fatigue failure, excessive motion and possible damage during installation. A key feature in an effective caisson design is that the upper part of the caisson should be made as small as possible so that wave loading and the caisson period can be minimized. The fatigue design procedure has been verified with past caisson operational experience. To illustrate the procedure, a flare pipe support caisson in 185 ft of water has been designed and analyzed.

33084 Digital technique for damping measurement of fixed platforms. Enochson, L. pp 375-404 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper describes a digital methodology for estimating damping and related structural parameters and the application of this methodology to a preliminary set of offshore platform data. The method involves a discrete Laplace transform and its implementation on a Time/Data minicomputer based Time Series Analysis System. The theory is perhaps complicated, however its application is simple. Data from analog tape are digitized and analyzed in a matter of minutes. We emphasize that this paper reports on a technique and methodology. The example data analysis illustrates the power of the Laplace transform but is incomplete in that adequate data were not available to provide sufficient accuracy for confidence in results at this time. The approach has been used successfully for determining damping in aircraft wings, and the example preliminary analysis presented in this paper shows the method also has promise for use with offshore platform response data. The mini-computer based Laplace transform technique provides a powerful tool to aid the structural dynamicist in proper design of offshore structures to solve an important problem facing this industry today.

33085 Approach to fire control in offshore operations in the North Sea. Everett, E.G.; Nehring, G. pp 405-416 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The frequency of the occurrence of fires in offshore operations worldwide is low and the majority of these can be dealt with at the location by trained personnel using installed fire-fighting equipment. Nevertheless, for the hostile environment of the North Sea with its huge complex platforms, considerable effort has been directed towards resolving the problem of dealing with fires of disaster proportion by planning to have special floating equipment available in order to preserve the integrity of the large multi-million dollar structures. The total approach to fire precaution and control is discussed. The paper summarizes the results of some two years of committee effort by the United Kingdom Offshore Operators Association Limited, which benefitted from worldwide experience of the oil industry, and as a result of which parameters were established for the design of purpose-built fire control vessels and proposals made for their location and operating mode in the areas of concentrated,

industrial activity in the North Sea. However, the approach is applicable to any area in the world where similar operating and environmental conditions prevail.

33086 Safety aspects and classification of deep diving systems. Tangen, H.D.; Evensen, G. pp 517-528 of In Eight annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The development and the application of Det norske Veritas' Rules for the Construction and Classification of Diving Systems are presented. System requirements and quality criteria are based on main principles of diving technology and physiology, reliability analyses, existing codes and regulations, and experience within industry and certifying bodies, as well as the Society's more than one hundred years experience in ship classification. The rules cover environmental conditions, materials, pressure vessel design, pipes, valves, fittings, manufacture, life support system, electrical installations, fire protection, control stand, communication, handling system, ballast and stability. Classification provides an international quality assurance throughout the lifetime of the diving system.

33087 Totally integrated navigation system. Ott, L.E. pp 409-430 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Increasing operating cost of marine geophysical surveys, coupled with expansion of surveys into deeper water and further from shore have placed new demands for reliability in navigation. To resolve ambiguities and to provide world-wide operation for all typically encountered conditions, a system was developed that will provide optimal real-time position information based upon the navigation satellite datum. The system is configured around a software program that optimally combines digitized data from whichever sensor units are active. Included among the sensor types are all radio navigation aids, a doppler sonar, a satellite receiver, and an inertial platform. The integrated character of the system allows continual automatic adjustment to optimal solutions during activation or deactivation of individual sensors. Several systems involving a variety of sensor configurations have been operational since September 1974. Most data presented is from Loran-C, an inertial platform, doppler sonar, and a satellite receiver. We expect further refinement in positioning once additional radio aids are incorporated.

33088 Pipelines and marine platforms. McDonald, R.D. (to Intercontinental Marine Development Ltd.). US Patent 3,988,898. 2 Nov 1976. Filed date 26 Dec 1974. 6p.

A marine platform is described incorporating a submerged buoyancy chamber which is anchored to drilled piles in the sea bed by cables. Each anchorage point lies inside a working chamber mounted on the pile to enable workmen inside the chamber to release the coupling between the cable and the pile when the cable needs to be replaced. The buoyancy chamber and the working chamber both have airlocks to enable the transfer of workmen between each chamber and a submersible craft. The buoyancy chamber supports a deck which lies above sea level. The deck is in fluid communication with a wellhead on the sea bed by means of risers. Each riser incorporates two concentric tubes. The inner tube carries oil from the wellhead and the other tube contains a hydraulic fluid through which valves at the wellhead can be controlled from the deck such that the valves close if riser rupture releases hydraulic pressure.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

33089 (ANL/NDM—25) Determination of the energy scale for neutron cross section measurements employing a monoenergetic accelerator. Meadows, J.W. (Argonne National Lab., Ill. (USA)). Jan 1977. Contract W-31-109-ENG-38. 33p. Dep. NTIS $4.00.

Persistent disparities between the energy scales used for broad-spectrum neutron source studies and monoenergetic neutron source studies has prompted an investigation of various factors which affect the determination of an energy scale for monoenergetic accelerators. Yield curves and neutron energy spectra were calculated for some (p,n) reactions commonly used as neutron sources or for energy calibration purposes. These calculations take into account the energy spread of the incident proton beam and the statistical nature of the proton energy loss. It is shown that, when thresholds are observed by detecting the 0 deg. neutron yield, the best results are obtained by plotting the square of the yield against the proton energy and extrapolating to zero yield. A linear plot can be in error by 1 to 2 keV if the energy spread of the proton beam is large. These factors also affect the shape of the neutron energy spectrum, although the average energy shows little change. A calibration was established for the Argonne Fast Neutron Generator by locating the $^{7}Li(p,n)^{7}Be$ threshold (1880.60 +- 0.07 keV) and the $^{11}B(p,n)^{11}C$ threshold (3016.4 +- 1.6 keV). This calibration was confirmed and extended by measuring the location of a carbon resonance (2077 +- 2 keV neutron energy) and by a time-of-flight measurement at 4.466 MeV neutron energy. The energy scale established by this procedure was consistent within experimental error. 9 figures, 2 tables.

33090 (ITEF—60) Collective acceleration methods and their development in ITEPh. Zenkevich, P.R.; Kapchinskii, I.M.; Plotnikov, V.K.; Chuvilo, .I.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1974. 18p. (In Russian). NTIS (US Sales Only).

39 refs.

The present state of collective acceleration methods development is briefly characterized. The investigation trends adopted at the Institute of Theoretical and Experimental Physics (ITEP) are discussed. Data are given on the ITEP experimental facilities and the work program for the near future.

33091 (LA—6702-PR) Intense neutron source facility. Progress report, October 1—December 31, 1976. Brown, M.C. (comp.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1977. Contract W-7405-ENG-36. 28p. Dep. NTIS $4.00.

Progress in the construction of the Beam-on-Target (B-O-T) prototype test facility is satisfactory, with no major delays in the schedule. Particularly encouraging is the progress made with the annular-type duoplasmatron. Improvement in filament conditioning procedures has led to very stable multiple-arc operation. The question of beam neutralization is being addressed as it applies to the design of both B-O-T transport and INS transport equipment. The neutralization is very helpful in reducing the number of focusing magnets required in the beam transport systems. Standard circuits and practices are being developed for all computerized linear data and control channels for B-O-T and INS instrumentation. Operation of a mock-up differential pumping system produced expected results for air; primarily, most of the leakage gas (98 percent), simulating backflow from the jet target, was pumped by the first stage. This assures a very steep density gradient as the jet target is approached. The prototype isotope separator system has been successfully operated, using a ternary mixture of hydrogen, hydrogen deuteride, and deuterium. The results show that the progressive enrichment of deuterium toward the bottom end of the column is close to the theoretical predictions, indicating the 18-in. continuously packed long column should represent about six theoretical separation stages. The supersonic jet target experiments have been extended with heat addition of 48 percent of the jet flow enthalpy. The flow remains unchoked and stable, with the back flow into the access port increasing some 20 percent over the unheated condition. The shielding task force continues its preliminary studies to determine 14-MeV neutron shielding requirements for the facility. The Process updated time and cost schedules.

33092 (UCRL—79151) Brief history of the MTA project. Van Atta, C.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Jan 1977. Contract W-7405-ENG-48. 28p. (CONF-770107—1). Dep. NTIS $4.00.

From Information meeting on acceleration breeding; Upton, New York, United States of America (USA) (18 Jan 1977).

The history of the MTA program (1949-1954), the purpose of which was to develop a deuteron accelerator and target assembly appropriate for electronuclear breeding of ^{239}Pu and ^{233}U, is briefly reviewed. The elements of the program are listed; the development of experimental Alvarez-type accelerators is discussed, and the conceptual design of a production plant is described together with estimated capital investment and cost of ^{239}Pu to be produced. Despite favorable progress the program was terminated when extensive deposits of mineable uranium were found in the U.S.

33093 Rossendorf large-scale nuclear equipment and its application in science and technology. Weibrecht, R.; Hieronymus, W.; Richter, E. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Isotopenpraxis;* **12**: No. 3, 97-106(Mar 1976). (In German).

A survey is presented on the nuclear equipment of the Central Institute of Nuclear Research of the Academy of Sciences of the GDR. It involves the Rossendorf research reactor, the U-120 cyclotron, the 2 MV Van-de-Graaff generator, and the EGP-10-1 tandem-type generator. A summary is provided considering the application of these facilities for the solution of tasks in basic research, applied research, and industry. Organization and mode of operation of the facilities are described.

AUXILIARIES AND COMPONENTS

INJECTION AND EXTRACTION SYSTEMS

33094 Use of a helical undulator to produce a high-energy electron beam with a small hadron impurity in a proton accelerator. Alferov, D.F.; Bashmakov, Y.A.; Bessonov, E.G.; Govorkov, B.B. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 191-192(Jun 1976).

The radiative energy loss of an electron moving on the axis of a helical magnetic field is proposed as a means of separating electron and hadron beams. (AIP)

STORAGE RINGS

33095 (SLAC-PUB—1815) **High duty factor structures for e^+e^- storage rings.** Allen, M.A.; Karvonen, L.G. (Stanford Linear Accelerator Center, Calif. (USA)). 1976. Contract EY-76-S-03-0326. 4p. (CONF-760942—27). Dep. NTIS $3.50.

From Conference on proton linear accelerator; Ontario, Canada (14 Sep 1976).

The next generation of e^+e^- storage rings will need rf systems similar to those required for a continuous-duty linac of over 50 MeV. For the PEP Storage Ring at 18 GeV, it is presently planned to provide a peak accelerating voltage of 77 MV in 18 aluminum accelerating structures, each structure consisting of five slot-coupled cells operating in the π mode. The power dissipation will be 100 kW per cell for a total of 500 kW per five-cell structure at 353 MHz. A two-cell model was designed and built to dissipate 100 kW per cell or a total of 200 kW. This structure was powered (cw) to over 100 kW per cell, and detailed calorimetric data were taken and compared with the original heat transfer calculations. The power level achieved corresponds to a peak accelerating field (transit-time factor included) in the two-cell model of 0.8 MV per cell or 1.9 MV/meter. Operating experience with the SPEAR five-cell structure is discussed. The four SPEAR structures are each designed to operate with wall losses of 75 kW and up to 50 kW into the stored beam. Power to each structure is provided by a 125-kW high-efficiency four-cavity klystron. No isolation has been used and the resulting interaction between the accelerating structures, klystrons, and the stored beams is discussed.

33096 Six pulsers built for use in the SPEAR East Interaction Area (24 Jun 1976) (Engineering Materials). (Stanford Linear Accelerator Center, Calif. (USA)). (CAPE—2562).

37 drawings.

A complete set of fabrication drawings is given for the six pulsers built for use in the SPEAR East Interaction Area (originally for the SP-7 experiment). The pulsers are used to trigger a large array of cylindrical magnetostrictive wire chambers, a basic track detector for high energy sub-atomic particles. Using the specified cable assemblies, these units produce pulses of about 150 nanoseconds duration and approximately 30 nsec risetime at an amplitude of 5 kV into 0.825Ω (48 to 33Ω cables in parallel). The delay from input trigger to leading edge of the output pulse is approximately 60 nsec. Also included are a block diagram of the entire system as installed and a drawing of the control unit which connects the five pulsers, one pre-pulser and three high voltage power supplies.

INSTRUMENTATION

REFER ALSO TO CITATION(S) 31795, 31889

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 32418, 32557, 32558, 32559, 32560, 32561, 32576, 32595, 33045

33097 (AED-Conf—76-421-001) **Separation of heavy ion tracks in nuclear emulsions by means of the pulsed electric field.** Akopova, A.B.; Magradze, N.V.; Melkumyan, L.V.; Prokhorenko, Y.P. (AN Armyanskoj SSR, Erevan. Inst. Fiziki). 1976. 7p. (CONF-760964—10). NTIS (US Sales Only).

From 9. international conference on solid state nuclear track detectors; Neuherberg/Munchen, German, Federal Republic of (F.R. Germany) (30 Sep 1976).

1 fig.; 1 tab.; 6 refs.

The pulsed electric field (PEF) technique is developed for the separation of heavy ion tracks from the intense background caused by high energy electrons, protons and γ-radiation. The tracks of Ne, Cr, Ar-ions accelerated at the Dubna Nuclear Reactions Laboratory have been separated from the background, the voltage of the applied PEF being 10^5 V/cm.

33098 (SAND—76-5547, pp 223-240) **Survey of coded aperture imaging.** Barrett, H.H. (Univ. of Arizona, Tucson). Nov 1975.

From Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities; Albuquerque, New Mexico, USA (11 Nov 1975).

In Transactions of conference on fuel and clad motion diagnostics in LMFBR safety test facilities.

The basic principle and limitations of coded aperture imaging for x-ray and gamma cameras are discussed. Current trends include (1) use of time varying apertures, (2) use of "dilute" apertures with transmission much less than 50%, and (3) attempts to derive transverse tomographic sections, unblurred by other planes, from coded images. (WHK)

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 32564

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

33099 (GSI-M—3-76) **Detection and identification of heavy ion reaction products.** Armbruster, P. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). 1976. 15p. (AED-Conf—76-501-002;Conf-760943—9). U PC A02/MF A01.

From European conference on nuclear physics with heavy ions; Caen, France (6 Sep 1976).

9 figs.; 4 tabs.; 52 refs. Paper will be published in the proceedings.

There are different types of heavy ion reactions, which ask for different detection and identification methods. An outline of methods adequate for the different reactions is given. What has been achieved is demonstrated following different experiments actually performed. Some instrumental improvements still to be realised are proposed.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 33096

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 33108, 33149

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

33100 (AD-A—026364) **Analysis of electronic component damage due to EMP. Final technical report Jan—Jun 1976.** Bell, R.B. (Frank J. Seiler Research Lab., United States Air Force Academy, Colo. (USA)). Jun 1976. 61p. (FJSRL-TR—76-0009). NTIS (US Sales Only).

Carbon composition, metal film, carbon film, and metal oxide type resistors, damaged with electromagnetic pulses (EMP) of 0.1 microsec to 10 microsec, have been examined using a scanning electron microscope (SEM). Failure mechanisms as a function of EMP pulsewidth were investigated with specific interest in arcing failure at short pulsewidths. Evidence of arcing damage was found in all three film type resistors associated with the helix trimming cut in the film layer. Theoretical electric field potential profiles of the resistive film layer are supported by SEM photographs. This project was supported by AFWL/DYX, P.O. AFWL 76-201, through Frank J. Seiler Research Laboratory, W.U. 7903-03-88. (GRA)

33101 Investigation of the influence of γ irradiation on diffused gold-doped silicon diodes. Berman, L.S.; Shuman, V.B. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **10**: No. 12, 1416(Dec 1976).

Irradiation with ^{60}Co γ rays at T 40 degreeC with a dose of 3.2 x 10^8 R did not affect the gold concentration profiles but it did create A centers and defects with a level at E/sub v/+0.35 eV. Irradiation did not alter the concentration of the electrically active gold and the presence of gold had practically no influence on the rate of introduction of the A centers.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 31788, 31873, 31876, 31877, 31884, 31909, 31951, 31952, 31953, 31954, 31955, 31956, 31957, 31958, 31959, 31960, 31961, 31962, 31963, 31966, 31967, 31968, 31969, 31970, 31971, 31972, 31973, 31974, 31975, 31976, 31977, 31978, 31979, 31980, 31981, 31982, 31983, 31984, 31985, 31986, 31987, 31988, 31991, 31994, 31996, 31999, 32001, 32002, 32003, 32006, 32007, 32008, 32009, 32012, 32013, 32014, 32015, 32016, 32017, 32018, 32019, 32020, 32021, 32022, 32023, 32026, 32027, 32101, 32416, 32419, 32501, 32541, 32574, 32577, 32639, 32650, 33181

33102 Magnetic transit-time flowmeter. Forster, G.A. (to Energy Research and Development Administration). US Patent 3,967,500. 6 Jul 1976. Filed date 29 May 1975. 8p.
PAT-APPL-581,607.
The flow rate of a conducting fluid in a stream is determined by disposing two permanent-magnet flowmeters in the stream, one downstream of the other. Flow of the conducting fluid causes the generation of both d-c and a-c electrical signals, the a-c comprising flow noise. Measurement of the time delay between similarities in the a-c signals by cross-correlation methods provides a measure of the rate of flow of the fluid. 8 claims, 8 figures.

33103 Electromagnetic radiation detector. Benson, J.L.; Hansen, G.J. (to Energy Research and Development Administration). US Patent 3,983,437. 28 Sep 1976. Filed date 12 Mar 1968. 6p.
PAT-APPL-713,279.
An electromagnetic radiation detector including a collimating window, a cathode member having a photoelectric emissive material surface angularly disposed to said window whereby radiation is impinged thereon at acute angles, an anode, separated from the cathode member by an evacuated space, for collecting photoelectrons emitted from the emissive cathode surface, and a negatively biased, high transmissive grid disposed between the cathode member and anode. 9 claims, 4 figures.

33104 Dialable ampere current source with ovenless construction and ppm/h stability. Norris, C.B.; Stuart, D.T. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Rev. Sci. Instrum.;* **48**: No. 3, 229-231(Mar 1977).
This paper describes the design and construction of a highly stable, dialable current source developed for use with an electron beam transport system. The current regulator is ovenless and employs thermal feedback to cancel effects of ambient temperature variation and self-heating in the current-sensing resistor. The regulator is of modular design and incorporates remote control features to facilitate use in applications requiring many current channels. The output current can be modulated to permit Monte Carlo beam optimization. The output stability is better than +- 1 ppm/h at an output current of 1 A, in an environment subject to +- 1 degreeC temperature variation, measured using instrumentation having a nominal stability of +- 1.5 ppm/h.

33105 Correction of atomospheric distortion with an image-sharpening telescope. Buffington, A.; Crawford, F.S.; Muller, R.A.; Schwemin, A.J.; Smits, R.G. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *J. Opt. Soc. Am.;* 7: No. 3, 298-303(Mar 1977).
We have built and tested a 30 x 5 cm aperture telescope which used six movable mirros to compensate for atmospherically induced phase distortion. A feedback system adjusts the mirrors in real time to maximize the intensity of light passing through a narrow slit in the image plane. We have achieved essentially diffraction-limited performance when imaging both laser and white-light objects through 250 m of turbulent atmosphere. The behavior of our telescope was accurately predicted by computer simulations. The system has yet to achieve its full potential, but has already operated successfully for objects as dim as 5th magnitude.

33106 First observatory results with an image-sharpening telescope. Buffington, A.; Crawford, F.S.; Muller, R.A.; Orth, C.D. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *J. Opt. Soc. Am.;* 7: No. 3, 304-305(Mar 1977).
The image-sharpening telescope described in the preceding article was installed and operated on equatorial mounts at both Leuschner Observatory and Lick Observatory. We present measurements of the characteristic speckle change times for stars observed at these locations. We also present sharpened images of Sirius and Arcturus.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 31793, 31809, 31810, 31811, 31812

33107 (PB—255499) **Calibration models for geophysical borehole logging. Report of investigations.** Snodgrass, J.J. (Bureau of Mines, Denver, Colo. (USA). Denver Mining Research Center). Jun 1976. 27p. (BM-RI—8148). NTIS (US Sales Only).
The Bureau of Mines designed and constructed a series of calibration models for geophysical borehole logging at the Denver Federal Center, Denver, Colo. The models are available for use by government agencies and private industry to calibrate logging equipment for measurements of density, sonic velocity, magnetic susceptibility and electrical resistivity. A nominal hole diameter of three inches was selected as representative of typical core holes drilled for mining and engineering purposes, although additional hole diameters of 2, 5, and 8 inches are provided in one of the models for determination of empirical correction factors for variations in hole diameter. The physical properties of the models were determined by laboratory analyses of drill core samples and evaluated statistically for reliability. This report outlines the location of the models, elements of design and construction, and results of the laboratory tests.

33108 Effects of mudcake and sonde angle on a simple two-detector density sonde. Hearst, J.R. (Lawrence Livermore Lab., Livermore, CA). *Log Anal.;* 17: No. 3, 11-15(1973).
A simple analysis is made of a well-collimated two-detector density sonde with a tight energy window, the simplest form of two-detector sonde. Under these circumstances density can be obtained either in the presence of a constant unknown thickness of mudcake of unknown properties or in the presence of an unknown angle between the sonde and the borehole wall, with the source in contact. If both a mudcake (or a gap) and an angle are present, the problem cannot be solved unless the angle or the gap is measured. If the gap (or mudcake thickness) is measured, the solution is probably too complex for field use. If washouts are present the problem cannot be solved but can sometimes be dealt with by averaging.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 33111, 33113

33109 (UCRL—52175) **New booster explosive, LX-15 (RX-28-AS).** Golopol, H.A.; Fields, D.B.; Moody, G.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Dec 1976. Contract W-7405-ENG-48. 28p. Dep. NTIS $4.00.
LX-15 (RX-28-AS) is a new booster explosive based on hexanitrostilbene (HNS). This formulation is comparable to PBX 9407 in performance in the slapper detonator, but with better thermal properties, and safer handling characteristics. The advantages of using HNS are as follows: high melting point (~315°C); relative insensitivity in handling; and allowability as an in-line explosive in MiL Std 1316 A.

NUCLEAR

REFER ALSO TO CITATION(S) 33194

33110 (AD—A029560) **Counterevasion studies - the effects of noise, dissimilarity, and prefiltering on cepstrum analysis. Semi-annual technical report no. 5, (pt. b), 1 May-31 Oct 75.** Sun, D. (Texas Instruments, Inc., Dallas (USA)). 30 Nov 1975. Contract F44620-73-C-0055,. 82p. NTIS (US Sales Only) $5.00.
See also AD-A029 559.
The effects of the noise, the dissimilarity, and the prefiltering on the detection of the P-pP delay time and the successful decomposition of the mixed P- and -pP wave by employing the cepstrum analysis are studied here. These effects have been investigated by extracting the direct P-phases and the surface reflected pP-phases from several presumed underground explosions in eastern Kazakh, and remixing them at various time delays with the addition of various levels of the realistic seismic noise. The quality of the cepstrum analyzed results as a function of the signal-to-noise ratio, the delay time, and the dissimilarity between the P-phase and the pP-phase have been obtained for a number of such events. In general, it is found that the cepstrum analysis can detect the P-pP delay time as short as 0.4 second and successfully recover the P- and the pP-phases for the signal-to-noise ratio down to about 12 dB. When the similarity coefficient between the P- and the pP-phases is less than 1.0, the detection of the P-pP delay time becomes not so obvious as it is when they are identical. The dissimilarity between the P-Phase and the pP-phase will affect the detection of the P-pP delay time more seriously than the noise in the cepstrum analysis.

33111 (AD—A030060) **Analysis of explosively generated ground motions using Fourier techniques.** Blouin, S.E.; Wolfe, S.H. (Cold

Regions Research and Engineering Lab., Hanover, N.H. (USA)). Aug 1976. 93p. (CRREL—76-28). NTIS (US Sales Only) $5.00.

Fourier transforms of selected ground-motion time histories from five underground high-explosive and nuclear detonations are used to define the transmission properties (Transfer functions) of three rock types. Absorption, a measure of a rock's energy dissipating characteristics, is expressed for each of the tests as a function of the frequency of transmission. Dispersion results from a variation in transmission velocity with frequency and is described for each test by a phase velocity spectrum. The transmission properties from one of the sites are used to predict a ground-motion time history at that site from another nuclear event. The potential use of Fourier techniques to make ground-motion predictions and to measure in-situ material properties is discussed. (auth)

33112 (AD—A030165) **Vela network evaluation and automatic processing research. Quarterly report no. 4, 10 apr-10 jul 76.** Turnbull, L.S. Jr. (Texas Instruments, Inc., Dallas (USA)). 10 Jul 1976. Contract F08606-76-C-0011,. 17p. NTIS (US Sales Only) $3.50.

This fourth quarterly report summarizes progress under the VELA Network and Automatic Processing Research Program. Work in the following areas is summarized: array and network evaluation, signal detection methods, signal estimation techniques, and discrimination.

33113 (AD—A030303) **Plate tectonics and the discrimination of underground explosions from earthquake. Semi-annual report no. 1, 1 Oct 75—30 Mar 76.** Murphy, A.J. (Columbia Univ., Palisades, N.Y. (USA). Lamont-Doherty Geological Observatory). 19 Aug 1976. Contract F19628-76-C-0075,. 9p. NTIS (US Sales Only) $3.50.

During the six month period covered by the report given, research was carried out in the following three areas: (1) a study of the velocity structure under the Tibetan Plateau using at least ten Tibetan earthquakes recorded by nearby WWSSN stations; (2) a study of causes of variations in Ms-M sub b relation for a Central Asian earthquake sequence to determine what factors other than source depth and focal mechanism control the surface wave magnitude for small events; and (3) a study of the distribution of great shallow earthquakes.

CIVIL USES

REFER ALSO TO CITATION(S) 31818, 31924

WEAPONRY

33114 (SAND—76-0680) **Design and fabrication of a telemetry antenna restraint for the artillery fired atomic projectile.** Mead, K.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract E(29-1)-789. 22p. Dep. NTIS $3.50.

A filament wound Kevlar 49-epoxy composite restraint has been designed to support a microstrip antenna on the conical forward section of an 8 inch artillery shell. The restraint was required to withstand an angular acceleration of 158 x 10^3 rad/s^2, a spin rate of 12,000 rpm and a set-back acceleration of 11,000 g. In addition it was required to function over a temperature range of minus 30 to plus 150°F to have a small enough thickness to minimize the change in aerodynamic performance of the projectile. The restraint has a midpoint diameter of 7.5 inches, and covers approximately 3 axial inches of the surface. Design stress calculations indicated that a 0.040 inch thick restraint, with a quasi-isotropic winding pattern, would meet all requirements. The dielectric properties of the restraint and of the nitrile rubber modified epoxy adhesive that cover the antenna were satisfactory for telemetering transmission. Four antennas with restraints have been successfully fabricated, assembled and test fired. After parachute recovery of the projectile, the antenna-restraint-system was found in reusable condition.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 32909, 33130, 33132, 33133, 33134

33115 **New method of calculating the air pollution from industrial emissions.** Onikul, R.I. pp 21-32 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Theoretical and experimental studies made on air pollution are reviewed. These studies were used as the basis for developing new standard methods for the calculation of atmospheric pollution. The basic formulas used for the calculation of the ground-level concentration under unfavorable meteorological conditions were given for the case of hot and cold emissions from flue stacks, skylights, and ventilator shafts. The role of the height of the flue stacks and centralization and temperature of the emissions with respect to the structure of the formulas is examined. The practical use of these methods is indicated.

33116 **Laws and mechanisms for the breakdown of air exchange in mines.** Alekseeva, Z.I.; Bitkolov, N.Z.; Bondar, L.G. pp 147-149 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Generalized data, characterizing the singularities of meteorological factors in mines and the air pollution associated with them, are reported.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31767, 31768, 32199, 32288, 32289, 32290, 32291, 32292, 32295, 32890, 33201, 33239

33117 (AD—A029400) **Comparison of environmental impacts of coal and nuclear systems for military utility application and consequences of reactor accidents. Final report.** Doyle, M.R.; Golay, M.W.; Rasmussen, N.C. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Feb 1975. Contract DAAK02-74-C-0308. 126p. NTIS (US Sales Only) $6.00.

This study compares the environmental impacts of a coal district heating station and a high temperature gas cooled reactor total energy system. In addition, the consequences of nuclear accidents are predicted. Radioactive, chemical and thermal emissions from the two plants are determined and methods of control are discussed. The costs of control systems are estimated from a variety of sources including current prices provided by manufacturers. The consequences of nuclear accidents are predicted by use of the computer model developed for the Wash 1400 Reactor Safety Study of the Atomic Energy Commission. This model predicts the number of acute deaths, illnesses, cancers, and genetic diseases and the monetary cost which would be expected from the worst possible accident at the nuclear plant. (Author) (GRA)

33118 (BNWL—2141) **Master schedule for CY-1977 Hanford Environmental Surveillance Routine Program.** Blumer, P.J.; Myers, D.A.; Fix, J.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1976. Contract EY-76-C-06-1830. 31p. Dep. NTIS $4.00.

Data are presented from the routine environmental surveillance program at the Hanford Site as conducted by the Environmental Evaluation Section of Battelle, Pacific Northwest Laboratory for ERDA. Tables are presented to show levels of radioactive and nonradioactive pollution in the Columbia River, sanitary water, surface water, ground water, foods, wildlife, soil, and vegetation. Data are also presented for external radiation measurements using thermoluminescent dosimeters, results of portable instrument surveys, and monitoring of waste disposal sites. (HLW)

33119 (NTIS/PS—76/0921) **Beryllium pollution (a bibliography with abstracts). Report for 1964-oct 76.** Werner, K.G.; Brown, R.J. (National Technical Information Service, Springfield, Va. (USA)). Nov 1976. 109p. Q 01/MF/N01.

Supersedes NTIS/PS—75/772, and NTIS/PS—75/021.

The bibliography covers research on air and water pollution by beryllium. This includes sources; control; detection and analysis; toxic effects on plants, animals, humans; and air and water quality emissions. Environmental levels of radioactive and radiation-produced beryllium are excluded. (This updated bibliography contains 105 abstracts, 24 of which are new entries to the previous edition.) (GRA)

33120 (NTISUB/B—135-76/005) **Summaries of foreign government environmental reports. Number 45.** (Environmental Protection Agency, Washington, D.C. (USA)). May 1976. 50p. NTIS (US Sales Only) $4.00.

See also NTISUB/B/135-76/004.

The U.S. Environmental Protection Agency, under a series of documents exchanges with foreign governments and international organizations, is collecting environmental reports from around the world. Subject areas, which reflect EPA programs, include the following: Air, water, noise, solid wastes, pesticides, toxic substances, radiation, land use. (GRA)

33121 (NTISUB/B—135-76/006) **Summaries of foreign government environmental reports. Number 46.** (Environmental Protection

Agency, Washington, D.C. (USA)). Jun 1976. 44p. NTIS (US Sales Only) $4.00.

See also NTISUB/B-135-76/005.

The U.S. Environmental Protection Agency, under a series of documents exchanges with foreign governments and international organizations, is collecting environmental reports from around the world. This publication is a monthly announcement of documents received by EPA under the exchanges. In each issue the document summaries are grouped by subject, by category of document, and by country. Subject areas, which reflect EPA programs, include the following: Air, Water, Noise, Solid wastes, Pesticides, Toxic substances, Radiation, Land use. (GRA)

33122 (PB—256 858) **Guidelines for development of a quality assurance program: Volume XI. Determination of beryllium emissions from stationary sources.** Wohlschlegel, P.S.; Smith, F.; Wagoner, D.E. (Research Triangle Inst., Durham, N.C. (USA)). Apr 1976. Contract EPA-68-02-1234. 156p. NTIS (US Sales Only) $6.75.

See also Volume 4, PB-256 857.

Contents: Operations Manual--(Apparatus selection, Equipment calibration, Presampling preparation, On-Site measurements, Postsampling operations (base laboratory)); Manual for Field Team Supervisor--(Assessment of data, Suggested performance criteria, Collection and analysis of information to identify trouble); Manual for Manager of Groups of Field Teams--(Functional analysis of test method, Action options, Procedures for performing a quality audit, Data quality assessment). (GRA)

33123 (PB—258 853) **Application of remote techniques in stationary source air emission monitoring.** Ludwig, C.B.; Griggs, M. (Science Applications, Inc., La Jolla, Calif. (USA)). Jun 1976. Contract EPA-68-03-2137. 166p. (SAI—76-687-LJ). Q 02/MF/A01.

See also PB-247 771.

The usefulness of remote sensing techniques for monitoring the gaseous and particulate emissions from stationary sources is analyzed. The present status of active and passive remote monitoring instruments is evaluated. This study confirms that the technique of differential absorption has the best sensitivity for the single-ended measurement of gaseous and particulate pollutants. In general, data interpretation problems of the passive techniques make them less accurate than the active methods. (GRA)

33124 (PB—258 996) **Derivation of residual coefficients for typical polluting industries in new england. Final report.** Mlynarski, H.D.; Northrop, G.M. (Center for the Environment and Man, Inc., Hartford, Conn. (USA)). Oct 1975. 150p. (CEM—4162-537). Q 07/MF/A01.

This report contains a summary of the residual coefficients used in the residual generation model to convert population, employment, and other measures of economic activity to an annual amount of pollutants. This report serves two functions: (1) It tersely summarizes an extensive set of residual coefficients; (2) It presents their derivation and source documentation in a consistent manner. These residual coefficients are the multipliers used to calculate annual amounts of polluting residuals. The objective of this effort is to provide a clear description of the methodology and source documents used in the compilation of these coefficients in order to provide a framework through which similar data might be applied to other regions. (GRA)

33125 (PB—259 088) **Assessment of the air quality impact of SO_2 emissions from the Asarco-Tacoma smelter. Final report Jun 75-Jun 76.** Cramer, H.E.; Bowers, J.F.; Geary, H.V. (Cramer (H.E.) Co., Inc., Salt Lake City, Utah (USA)). Jul 1976. Contract EPA-68-02-1387. 222p. Q 10/MF/A01.

(PC A10/MF A01).

The major purpose of the work described in this report was to use diffusion modeling techniques to calculate the impact on ambient air quality of SO2 emissions from the ASARCO copper smelter in Tacoma, Washington for the existing smelter configuration (51-percent constant emissions control) and for 20 alternative smelter configurations with varying degrees of constant emissions control. The accuracy of the modeling techniques was established by the close correspondence obtained between calculated and observed short-term ground-level SO2 concentrations for 20 selected historical cases, when high hourly SO2 concentrations were measured in the area surrounding the smelter, as well as by the close agreement between calculated and observed annual average concentrations for 1972. The results of the model calculations show that the maximum allowable constant SO2 emission rate consistent with maintaining the Washington Department of Ecology (DOE) and Puget Sound Air Pollution Control Agency (PSAPCA) air quality standards ranges from 2000 to 2500 pounds per hour, depending on the source configuration. (GRA)

33126 (PB—259 299) **Technical manual for analysis of organic materials in process streams. Technical manual Jul 75-Jan 76.** Jones, P.W.; Graffeo, A.P.; Detrick, R.; Clarke, P.A.; Jakobsen, R.J. (Battelle Columbus Labs., Ohio (USA)). Mar 1976. Contract EPA-68-02-1409. 100p. Q 05/MF/A01.

(PC A05/MF A01).

The manual presents a very simple, yet informative, analytical strategy for the purpose of initial survey, to ensure that important emission problems do not go undetected. It also presents a more complex and detailed scheme for use on samples given high priority by the initial survey analysis. The manual was developed because of a major problem associated with the analysis of potentially hazardous organic emissions: a very large number of organic compounds may be present in a given industrial sample. If exhaustive analytical methods were applied to every emission source to be assessed, costs would become completely unreasonable, and much effort would be misdirected on samples of little concern. A comparison volume, concerned with sampling of organic substances, is available, and has been fully coordinated with the technical manual to ensure compatibility. (GRA)

33127 (PB—259782) **Procedures for evaluating operations of ambient air monitoring networks: a manual.** Shnider, R.W.; Shapiro, E.S. (URS Research Co., San Mateo, Calif. (USA)). Aug 1976. Contract EPA-68-03-0473. 92p. NTIS.

This manual is designed to evaluate the efficiency of ambient air monitoring networks whose primary objective is to document compliance with or progress toward attaining ambient air quality standards. The manual provides methods to evaluate the efficiency of each of six operational areas: Network Plan and Design, Personnel Qualifications, Facilities and Equipment, Sampling and Analysis, Quality Assurance, and Data Utilization. A technique is presented for the overall integrated evaluation of the operational areas. A final section provides methods to evaluate the efficiency of budgetary allocations. (GRA)

33128 (PERC/RI—77/5) **Chemical characterization of diesel exhaust particulates.** Mentser, M.; Sharkey, A.G. Jr. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Mar 1977. 53p. Dep. NTIS $4.50.

High resolution mass spectrometry was used to analyze the organic material associated with diesel exhaust particulates in order to detect hazardous compounds. Diesel fuels and respirable coal mine dusts were also surveyed. Mass spectra were obtained on approximately 50 samples of particulates from diesel engine tests. The tests involved precombustion-chamber and direct injection engines operating in different modes of speed and load and using three grades of diesel fuel. Distribution of hydrocarbons changed in a characteristic manner as the speed and loading of the engines increased from idle to rated speed and full load. The composition profiles were little affected by engine or fuel type. The composition of diesel particulates was investigated as a function of particle size from less than 0.2 to greater than or approximately equal to 3.0 μm. Formulas of the polynuclear aromatics customarily found in exhaust particulates were identified. More oxidation occurred in the less than 0.2 μm fraction than in the larger size material. Mass spectra of respirable coal dust sampled in areas of a mine where diesel and electrical haulage of coal were used, were compared with spectra of uncontaminated coal dust from the same mine. Respirable ducts from the diesel haulage entry had numerous saturated aliphatics not found in the electrical haulage samples, and this is attributed to combustion of diesel fuel. Differences in composition between respirable mine dust and uncontaminated dust prepared from lump coal reflected contamination of respirable dust by hydraulic oils and lubricants. The mass spectral data of all samples were screened for toxic compounds. Formulas of possible toxic compounds in diesel particulates included saturated aliphatic hydrocarbons, oxygenates, and polynuclear aromatics. 7 tables, 21 fig. (DLC)

33129 (UCD—472-500) **Health effects of pollutants associated with fossil-fuel power generation: an indexed bibliography with abstracts.** Azevedo, J.; Berding, K.; Book, S.A. (California Univ., Davis (USA). Radiobiology Lab.). Apr 1976. Contract E(04-3)-0472. 189p. Dep. NTIS $7.50.

This bibliography of approximately nine hundred references was prepared as part of the Radiobiology Laboratory risk assessment program, designed to evaluate the health hazards associated with pollutants generated from fossil-fuel combustion for electrical power production. A continuing review of the available literature provides the necessary informational background and data base required for an effective appraisal of such risks. The articles in this bibliography comprise the first major section of the literature review. More articles are being reviewed continually, and these periodically will be arranged to update this original bibliography.

33130 **Problemyi kontrolya i obespecheniya chistoty atmosfery. (Problems of the control and guarantee of the purity of the atmosphere. All-Union seminar).** Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). 193p. (CONF-730497—).

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

The 28 papers dealing with various aspects of air pollution control from industrial emissions were compiled. Separate abstracts were prepared for selected papers. (JSR)

33131 Characteristics of urban air pollution and the role of meteorological factors. Bezuglaya, E.Yu. pp 14-20 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Some results obtained in the study of urban air pollution are reported. The correlations between concentration of SO_2 in the air and the number of inhabitants and between the CO concentration and the number of automobiles are emphasized. The characteristics of the transient changes in the pollution concentrations were shown. Two types of distribution of polluting substances were reported. They are caused by topographic and climatological conditions and by the location of pollution sources. As a result of meteorological factors the air pollution level can vary by a factor of two.

33132 Evaluation of the reduction of air pollution as a result of the rational distribution of fuel to metallurgical installations. Shapritskii, V.N. pp 33-41 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Problems on the rational distribution of coal, mazut, and natural, coke oven, and blast furnace gas to metallurgical installations were generalized with consideration of the concentration and formation during combustion of cyano and sulfur compounds, 3,4-benzypyrene, and CO and with consideration of the combustion conditions, calorific value of the fuels, and level of emissions. The analysis was made on the basis of an examination of the ratio of the quantity of noxious material formed during the combustion of fuel containing 1 Mkcal to the maximum permissible concentration for populated areas and industrial areas. Practical recommendations are given and it is shown that by rational fuel distribution a substantial decrease can be attained in the pollution by industrial areas containing metallurgical installations.

33133 Experimental investigation of the air pollution of urban areas. Goroshko, B.B. pp 42-51 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The principles of the methods used in monitoring the air pollution of urban areas are examined. It is shown that these methods depend on the dimensions and industrial development of the cities, the character of the distribution and types of industrial plants, and a series of other factors which are briefly cited.

33134 Predicting air pollution. Con'kin, L.R.; Solomatina, I.I. pp 52-59 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The problems of predicting air pollution in the area of a single pollution source and in the town as a whole are examined. The meteorological conditions determining the level of polluting agents and methods for predicting them are discussed. Some examples are given of the prediction of air pollution in specific cities.

33135 Dependence of the air pollution in Moscow on the meteorological conditions. Petrenko, V.K.; Arshinova, V.I. pp 69-75 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

An evaluation is made of the air pollution from SO_2 and NO_2 in different regions of the city. The daily and annual variation of the air pollution is reported. The dependence of the pollution on basic meteorological parameters such as atmospheric stratification, direction and velocity of the wind, and precipitation is examined.

33136 Use of automatic methods for the recording and acquisition of data on air pollution. Zaitsev, A.S.; Vol'berg, N.Sh. pp 76-84 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The current status of development and use of automatic continuously working gas analyzers in an air pollution monitoring system is discussed. Some results obtained in the analysis of data on the recording of CO and SO_2 under urban and suburban conditions are reported.

33137 Development of a system for the continuous acquisition and processing of data on air pollution. Shcherban, A.N.; Primak, A.V.; Pokarzhevskii, A.S.; Kopeikin, V.I.; Kosinov, B.V. pp 85-100 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

An analysis is made of foreign automatic systems for monitoring air pollution. The principles for the development and construction of an automatic system, developed by the authors, are discussed. The structural design and functional characteristics of the peripheral stations and the data acquisition and processing center are described.

33138 Optimization of automatic data processing and modeling air pollution processes. Shcherban, A.N.; Primak, A.N.; Furman, N.I.; Marusov, A.G.; Dyshlevyi, V.S.; Fedorenko, G.N.; Bondarenko, N.I. pp 101-105 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

In order to obtain operative data on air pollution, expediency in the preliminary processing of data at the peripheral automated stations for air pollution monitoring and control is necessary. Automatic provisions for providing this are proposed.

33139 Formation of photochemical smog as a function of the air pollution and the intensity of ultraviolet radiation. Dmitriev, M.T. pp 106-112 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The results of kinetic calculations on the formation of photooxidants in conversion to ozone as a function of the air pollution and the intensity and wave length of the uv radiation were reported. It was shown that in the calculation of the rate of the photochemical reaction the concentrations of O, CO, and other substances in the air are the reference values. Simultaneously it is necessary to introduce the characteristics of the uv radiation, whose intensity and spectral distribution are determined by the geographic position of the region, the height of the sun, the cloudiness, and the ozone content of the atmosphere. These parameters have a daily, annual, and meridional variation.

33140 Ozone under conditions of atmospheric pollution in the region of Moscow. Britaev, A.S. pp 113-118 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Measurements of the ozone concentration made in Moscow and its suburbs with electrochemical analyzers showed that in the city the density of ozone was almost twice as low, but the amplitude of the daily variation was in some cases greater than in the suburbs. The maximum ozone concentration was observed in the summer during anticyclone weather. The vertical distribution of the ozone in the lower 500-m layer, established by measurements on television towers, was characterized by a series of maxima and minima. The magnitude of the maxima and minima was determined by dynamic and physico-chemical processes in the atmosphere.

33141 Propagation of chlorides in coastal regions and their effect on the corrosion of metals. Petrenchuk, O.P. pp 123-131 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The results of experimental studies of the propagation of chlorides on the Black Sea coastal regions of the Crimea were reported. On the basis of an analysis of the data obtained expressions were obtained for the dependence of the chloride concentration in

the air on the wind velocity. Empirical relations were established characterizing the decrease of chloride concentration as a function of the distance from the sea. The effect of chloride compounds on the corrosion rate of metals was evaluated. A quantitative ratio was derived expressing the dependence of the corrosion of metals with distance from the coast. Another ratio correlated the corrosion rate with the chloride concentration in the air.

33142 Study by the impact method of the disperse composition of industrial emission of particulates. Volkova, S.S.; Goroshko, B.B.; Ovchinnikova, E.I. pp 132-135 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Results obtained in the use of multicascade impactors in the study of the disperse composition of industrial dusts were reported. Typical curves were given showing the particle distribution as a function of particle size and its distance from the flare gases of industrial installations.

33143 Spectral analysis of atmospheric dusts from different sources. Aleksandrov, N.N.; Gunchenko, A.I.; Panichev, N.A.; Turkin, Yu.I. pp 136-139 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

A spectral method for the determination of the concentration of microelements in small single samples of atmospheric dust was described. The sensitivity of the method for different elements is 10^{-7} to 10^{-8} g. This makes it possible to measure the concentration of microtraces by an order lower than the maximum permissible concentration. The standard used in the spectral determination contained the oxides of Pb, Cr, Mn, Ti, V, Zn, Ni, Zr, Be, Sn, and Sr.

33144 Rapid method for the determination of nitrogen oxides in the flue gas of thermal power plants using the gas analyzer GKh-4. Lipshtein, R.A.; Shtern, E.N.; Nikiforova, V.V.; Efendiev, T.B.; Aleshina, N.I.; Gordeeva, N.P.; Medvedeva, O.S. pp 140-146 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

A method is proposed for the determination of nitrogen oxides in flue gases. It consists of the preliminary dilution of the gas to be analyzed and the passage of 0.5 l of this diluted gas through the indicator tubes of the GKh-4 gas analyzer. The tubes were thermally stabilized at 20 +- 1°C. The degree of preliminary dilution is selected so that the reading on the indicator tube is 0.0010 to 0.0013 vol. percent.

33145 Air pollution in Moscow from automobile exhaust gases. Partsef, D.P.; Zolotarevskii, L.S.; Revich, B.A. pp 165-167 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The relations among the degree of air pollution from exhaust gases, the congestion of motor transport, and the highway width are derived. The concentration of pollutants changes during the day and also has seasonal variations. A mathematical model was constructed correlating the pollution with the basic parameters of operation of an automobile in the city and its streets. A method was proposed for the calculation of the CO emission in the exhaust gases.

33146 Determination of the dependence of the concentration of nitrogen dioxide near highways on the level of movement of motor transport. Kirillov, G.P.; Fel'dman, Yu.G. pp 168-172 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The results of measurements on air pollution from nitrogen dioxide caused by automobiles are reported. On the basis of these results relations were obtained between the concentration of NO_2 and the type, speed, and congestion of motor transport for specific highways.

33147 Meteorological conditions for increased air pollution in the vicinity of single sources. Roskina, Yu.Ya.; Tserfas, K.E. pp 173-179 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

The meteorological conditions causing air pollution in the vicinity of a carborundum plant in Tashkent and an electrochemical installation in Chirchik were examined. For these installations and from the data on the emission parameters, the dangerous wind velocity was calculated. The relation between the concentration of chemicals in the air and the meteorological parameters was studied. The synoptic processes determining the pollution of the ground-level atmosphere were analyzed. The meteorological conditions under which the most significant accumulations of impurities in the urban air were observed were formulated. The pollutants measured were primarily H_2S, SO_2, NH_3, and NO.

33148 Reinforced coagulation-sedimentation model for stratospheric aerosols. Burgmeier, J.W. (Univ. of Vermont, Burlington); Blifford, I.H. Jr. *Water, Air, Soil Pollut.;* **5**: No. 2, 133-147(Dec 1975).

A numerical model is constructed to simulate the aging of the aerosol size distributions in the stratosphere in the presence of sources, and to calculate mean residence times in the absence of sources. It incorporates the mechanisms of thermal coagulation, gravitational sedimentation and gas reactions. Computations using this model indicate that for the rather different aerosol spectra measured by Bigg, Friend and Junge, only that of Bigg is consistent with the residence times that have been determined for stratospheric particulates. An upper limit for the stratospheric production rate of reacting gases is estimated to be of the order of 10^{-20} g cm^{-3} s^{-1}.

33149 Recent studies on the electron capture detector. Bros, E.; Chamberlain, A.T.; Page, F.M.; Patel, S.P. (Aston Univ., Birmingham (UK)). pp 259-274 of In Measurement, detection and control of environmental pollutants. Vienna; IAEA (1976).

From International symposium on the development of nuclear-based techniques for the measurement, detection and control of environmental pollutants; Vienna, Austria (15 Mar 1976).

A theoretical model is presented which takes into account the positive ion space charge and predicts the electron capture detector response on the basis of carrier gas parameters. Factors affecting its normal operation, such as carrier gas flow and pressure, impurities (including water) and the nature of the radiation source have also been investigated. The presence of sample molecules, UF_6 and quinones, is considered together with the coulometric response of SF_6. Experimental conditions necessary for coulometric operation are outlined.

33150 171st national meeting of the American Chemical Society, Division of Environmental Chemistry. Vol. 16, No. 1. Chicago; American Chemical Society (1976). 261p. (CONF-760447—P1). Carnegie-Mellon Institute of Research $5.00.

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

Individual abstracts were prepared for 37 items in the proceedings.

33151 Nature, concentration, and size distribution of organic paticulates in the eastern part of the Southern California air basin. Pitts, J.N.; Grosjean, D.; Shortridge, B.; Doyle, G.; Smith, J.; Mischke, T.; Fitz, D. (Univ. of California, Riverside). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 1-3(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The organic fraction of aerosol samples (24h + 2h samples) from the California South Coast Air Basin was analyzed for total organic carbon and individual organic constituents. Data obtained during 6 mo. continuous monitoring for organic carbon showed organic particulate loadings to be lower than sulfate and nitrate loadings, and to accumulate in the lower part of the submicron range. Samples collected during photochemical smog episodes showed a similarity to ozone and peroxyacetyl nitrate concentration, indicating that a significant fraction is of secondary origin. Analysis suggests that aromatic hydrocarbons compete with cyclic olefins as aerosol precursors. The organic fraction of the samples were routinely analyzed for trace level contaminants, the results of which are given in tabular form. Secondary organic aerosols such as dicarboxylic acids were further fractionated and a monocarboxylic acid found. a list of contaminants found in gas phase air samples is included. Further testing indicated a definite mutagenic activity in the aerosol samples.

33152 Secondary organic aerosols and their gas phase hydrocarbon precursors. Grosjean, D. (California Inst. of Tech., Pasadena). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 4-7(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Secondary organic aerosols are responsible for adverse health effects and poor visibility due to their accumulation in the submicron range. Using a general kinetic scheme the author estimates the relative contribution of several classes of hydrocarbons to the formation of secondary particulates. Several unknown parameters had to be estimated due to the scarcity of data: ambient hydrocarbon concentrations, unknown rate constants, possible reactants, and aerosol formation ability terms. Results of this kinetic scheme showed that the contributions varied dramatically with the time scale considered. Cyclic olefins appear to be the most important class of aerosol precursors over short time periods (less than or equal to 5h) and aromatics over longer periods (approximately equal to 10h) C/sub 6^+/ alkenes are important, but paraffins and C/sub 6^-/ alkenes contribute very little. When applied to specific smog episodes a good qualitative and quantitative agreement was obtained between measured and predicted values.

33153 Separation and identification of some organic constituents of photochemical aerosol in Los Angeles. Tsou, G.; Gibbons, D.; Holmes, J.R. (Air Resources Board, El Monte, CA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 8-11(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

After a brief explanation of why such research is necessary, the author summarizes his findings with respect to extraction, separation, and identification of the organic material in samples collected during the 1973-75 smog seasons (July-October). The ultraviolet spectrum showed no absorption in the 200-700 nm region, but the N.M.R. spectra showed broad peaks at 8 values of 7.1 ppM (aromatic CH), 3.6 - 3.0 ppM (-CH or -CH_3) with an adjacent electronegative atom (oxygen), and 1.1 - 0.2 ppM (aliphatic CH_2 or CH_3) with peaks in ratio of 1:60:200 respectively. The majority of this material consisted of oxygenated alkanes with little aromatic content. The presence of organic nitrates was suggested also. Results of esterification and mass spectroscopy and carbon 13 N.M.R. confirmed earlier findings that dicarboxylic acids and monocarboxylic acids with 1 or more additional polar substituents contribute significantly to the mass of organic aerosol and falls in the weight range of C_8 - C_{22}. 3 graphs and a map of wind trajectory in Los Angelos are given.

33154 Composition of certain atmospheric aerosols. Mendenhall, G.D.; Jones, P.W.; Graffeo, A.P.; Schwartz, W.E. (Battelle Columbus Labs., OH). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 12-13(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Organic analysis of model and atmospheric aerosols is described. Model aerosols were generated from toluene/NOx, toluene /NOx/SO_2, and 1-heptene/NOx/SO_2 under atmospheric simulation in the Battelle-Columbus 17m^3 environmental chamber. Samples of gas-phase and particulate organics from various urban sites collected under E.P.A. field-sampling programs, were also examined by several techniques. Aerosols were examined by elemental analysis, infrared spectroscopic analysis, gas and liquid chromatography, and by BC/MS analysis. Water extracts were analyzed for nitrate, sulfate, and ammonium ions. Results showed that little of the aerosol is sufficiently volatile to pass through a gc column and that many of the components were highly oxidized and polar species. A model chamber experiment to determine whether any organs products are formed later by chemical reaction on the filter indicated that exposure to H_2SO_4 aerosol does not lead to formation of sulfur compounds, but the sulfur species present were high polarity involatile materials.

33155 Microscopical analysis of aerosols transported from St. Louis. Draftz, R.G.; Graf, J.; Yamate, G. (IIT Research Inst., Chicago). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 17-18(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The study, sponsored by the Environmental Protection Agency, was to measure the transport and fate of sulfur dioxide from St. Louis' urban and powerplant plumes. These plumes were traced and sampled by instrumented aircraft at distances up to 300 miles from St. Louis. In addition to sampling SO_2, a special 4 stage impactor was constructed for sampling aerosols for microscopical analysis. Samples were returned to St. Louis within 2-4h after collecting and identified or classified by morphological properties. The major components were sulfuric acid or ammonium sulfate, usually found on the third stage (0.5 μm) and often 5 μm in length, indicating crystallization. Fly ash and mineral particles, some unusually carbonaceous deposits, and submicrometer sized clays and other minerals were also found. This study provided the first direct verification of sulfuric acid in urban atmosphere and also proof of the long range transport.

33156 Pollutant flow rate measurement in large plumes: sulfur budget in power plant and area source plumes in the St. Louis region. Husar, R.B. (Washington Univ., St. Louis); Husar, J.D.; Gillani, N.V.; Fuller, S.B.; White, W.H.; Anderson, J.A.; Vaughan, W.M.; Wilson, W.E. Jr. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 42-44(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The study focuses on the sulfur budget in large power plant and urban-industrial plumes. In low stacks the total sulfur flow rate decreases with distance: only about one-third of the original emissions are transported beyond a radius of 100 km. Evidence indicates that the formation of aerosol begins after an aging time of 1-2 h. In power plant plumes, the sulfur emitted from tall stacks leaves the region of 50-100 km essentially at the same rate as it is emitted at the source. Maps and graphs are included.

33157 Formation of ozone and light-scattering aerosols in the St. Louis urban plume. White, W.H. (Meteorology Research, Inc., Altadena, CA); Anderson, J.A.; Blumenthal, D.L.; Husar, R.B.; Gillani, N.V.; Fuller, S.B.; Whitby, K.T.; Wilson, W.E. Jr. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 45-48(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

An instrumented light aircraft was used to map the 3-dimensional flow of aerosols and trace gases in the St. Louis area on 18 July, 1975. It was found that under stable meteorological conditions the aggregate pollutant emissions often formed a cohesive, well-defined "urban plume" downwind of the city. This plume was broad and shallow, causing reduced visibilities and ozone concentrations in excess of the Federal Ambient Standard. It included emission of major nearby coal-fired power plants and a refinery complex, in addition to the industry and automotive traffic in the urban area itself. Ozone and light scattering aerosols were most prominant in the aged plume 50 km or more downwind of St. Louis, with ozone concentrations as high as 0.18 ppM, and light scattering coefficients up to 4.7×10^{-4} m^{-1} 125 km and more from St. Louis. They were 30-50 percent above their levels on either side and were produced chemically and physically, not directly emitted. Two figures are included which show concentrations and flow rates for this plume.

33158 Aerosol formation in a coal fired power plant plume. Whitby, K.T. (Univ. of Minnesota, Minneapolis); Cantrell, B.K.; Husar, R.B.; Gallani, N.V.; Anderson, J.A.; Blumenthal, D.L.; Wilson, W.E. Jr. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 49-52(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

In 1974 an instrumented aircraft was used to characterize SO_2, NOx, O_3, sulfate, and aerosols in the Labadie power plant plume near St. Louis, Mo. The paper deals with aerosol measurements. Volume flows of each pollutant were calculated from size distribution measurements, and wind velocities at each distance were measured. Tabulations (given in a table) show that although mean size increased from 0.24 μm at 10 km to 0.29 μm at 45 km, the size in the plume is not very different from the average for the upwind spiral. Volume flows (shown in a figure and table) show a 2 stage growth pattern; the growth rate increasing by a factor of 4 after 2 h., at a distance of 30 km. An alternative method used to show SO_2 conversion rate showed that 8 percent of the SO_2 was converted to aerosol at 45 km at a rate varying from 1.5 percent per h at 10 km to 4.9 percent per h at 45 km. Aerosol was 50 percent H_2SO_4 by weight at the relative humidity of 75 percent.

33159 Airborne sulfate occurrences and aerometric variables in regions of the United States. Hidy, G.M. (Western Technical Center, Westlake Village, CA); Tong, E.Y.; Mueller, P.K.; Hakkarinen, C. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 53-59(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The paper describes some of the findings on the regional and temporal distribution of water soluble sulfates collected daily on glass fiber filters mounted on high volume particulate samplers. for a 1 year period, 12 widely separated stations in the northeast quadrant

of the U.S. were studied. This region has the highest density of SO_2 emissions from industry, fuel burning, and other anthropogenic activities. Results show regional and seasonal distribution to be highest in the summer throughout the region, with monthly average sulfate concentrations ranging from 8 $\mu m/m^3$ in colder months to 20 $\mu g/m^3$ in summer. A relationship exists between occurrences of atmospheric sulfates and dew point temperature, with an increase of sulfates with increased temperature. In comparison with other data, a significant difference in sulfate behavior seems to occur in different geographical regions, with highest annual sulfate levels observed in the West Virginia—Western Penn. region. This suggests a cumulative effect of many large SO_2 sources situated in the path of an air mass combined with slow atmospheric oxidation processes.

33160 Chemical reactions in power plant plumes. Wilson, W.E. Jr. (Environmental Protection Agency, Research Triangle Park, NC); Husar, R.B.; White, W.H.; Whitby, K.T.; Kittleson, D.B. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 60-62(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

During Project MISTT studies in 1975, concurrent measurements of NO, NO_2, and ozone were made in plumes around St. Louis. It is clear that conversion of NO to NO_2 is dominated by the reaction with ozone in the background air that mixes into the plume. Later in the plume where substantial NO has been converted to NO_2, there is a sharp increase in the rate of conversion of SO_2 to sulfate aerosol. This 2 stage conversion process of SO_2 has also been observed in smog chamber studies, thus it would seem that NO inhibits sulfate conversion. Studies of SO_2 in purified air result in rates of 0.2 to 5 percent/hour. There is a statistical correlation between increased temperature and relative humidity, and increased conversion rates; therefore a homogeneous reaction mechanism might be favored, but heterogeneous reactions are also possible and are probably the most important nighttime processes. It is important to know the reaction mechanism in designing a control strategy for sulfate. Graphs and profiles included.

33161 Aerosol measurements using streaker samplers and proton beam analyses. Nelson, J.W. (Florida State Univ., Tallahassee). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 78-81(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

A complete elemental analysis of a sample of air particulate matter is possible using proton induced x-ray emission (PIXE) coupled with proton elastic scattering analysis (PESA). Both are nondestructive of the sample, suitable for measurements up to 1 mg/cm^2 areal density and amenable to automation for rapid quantitative determinations of large numbers of samples. In aerosol work, both filter and impaction samples may be used with typical loadings of several hundred micrograms/cm^2 over areas 1-10 mm^2, which has facilitated the design of compact, inexpensive air samplers for indoor and outdoor use. Graphs and Pictures are shown which illustrate usefulness of this method and the small sample size amenable to analysis by PIXE and PESA.

33162 Comparison of a virtual dichotomous sampler with a hi-volume sampler. Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC); McFarland, A.R.; Wedding, J.B. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 84-85(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

In relating respiratory disorders to fine particles, there is a relationship between size and chemical composition of the particle and incidence of disease. A new type of sampler has been developed that separates and collects particles into 2 size ranges: 0-3.5 to 20 microns. Called the virtual dichotomous sampler, it is equipped with a special inlet system designed to collect 20-micron particles at 50 percent efficiency independent of wind speeds up to 20 km/hr. Description of tests performed comparing hi-volume samplers with the dichotomous samplers.

33163 Evaluation of methods for measuring sulfate. Sawicki, C.R. (Environmental Protection Agency, Research Triangle Park, NC). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 88-89(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

A discussion of a program being conducted to evaluate and compare 5 wet chemical methods for determination of sulfate in atmospheric samples. The methods include $BaCl_2$ turbidimetric, automated methylthymol blue (MTB), AIHL microchemical, modified Brosset, and barium chloranilate. Parameters being evaluated are: equivalency of methods, analytical precision and accuracy, and the influence of potential interferents. Samples were collected with both high and low volume samplers in 4 different locations. Errors such as influence of filter medium, sampling volume and particle size are being evaluated. The first 4 wet methods yielded nearly equivalent results, indicating that the choice of method can be based on cost factors and convenience. Results from analysis of filters from low volume samplers revealed differences ranging from a factor of 2 per individual samples to 1.5 when pooled by sampling site (shown in a Table).

33164 High sensitivity flame photometric particulate sulfur analysis. Husar, J.D.; Macias, E.S.; Husar, R.B. (Washington Univ., St. Louis). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 90-93(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The paper presents a method for the determination of submicrogram quantities of particulate sulfur which in conjunction with a suitable filter material permits the measurement of ambient sulfur concentration with the time resolution on the order of 10 min. Data from experiments done on aerosol samples from St. Louis area indicate that sulfur constitutes about 10 percent of the fine particulate mass, but less than 2 percent of the coarse particulates. These experiments show the utility of high time resolution sulfur analysis in combination with the mass monitor. Graphs included.

33165 Separation and analysis of aerosol sulfate species at ambient concentrations. Tanner, R.L.; Newman, L. (Brookhaven National Lab., Upton, NY). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 128-130(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Since the knowledge of the qualitative and quantitative nature of the cations associated with airborne sulfate may be essential in development of controls and establishment of a "sulfate standard," a solvent extraction scheme has been developed wherein one can determine the sulfuric acid, bisulfate and "other soluble sulfate" contents of individual airborne particle samples. When combined with particle size separation and air mass trajectory analysis, these solvent extraction and cation/anion balance methodologies can substantially contribute to the realistic assessment of the health hazards of airborne sulfate.

33166 Sulfuric acid analysis using low temperature volatilization. Lamothe, P.J.; Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 131-132(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

In reponse to the need for a good method for continuously monitoring particulate sulfates and the development of a sulfuric acid monitor, the EPA issued a contract to the Cabot Corporation to develop a prototype automatic sulfuric acid monitor. The paper describes the basic analytical methodology and the laboratory and field evaluation of the prototype monitor. The limit of detection is 0.25 μg of H_2SO_4 deposited on the filter, and the precision using standard samples is +- 10 percent.

33167 Characterization of atmospheric aerosol by physical and chemical methods. Dzubay, T.G.; Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 136-139(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

In order to determine the performance capabilities of new methods to measure the mass and composition of atmospheric aerosol, an extensive set of analysis was made on samples collected in St. Louis in August and Sept, 1975. To obtain a variety of chemical matrices, sampling was done simultaneously at a rural and urban site which are part of the network used in the Regional Air Pollution Study. Preliminary results indicated that Sulfur accounts for 10 percent of the fine particle mass at both the urban and rural site. For sulfur, a total of 12 combinations of methods and samplers were intercompared.

33168 Recent and projected developments in chemiluminescence monitoring of air pollutants. Fontijn, A. (AeroChem Research Labs., Inc., Princeton, NJ). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 154-157(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Chemiluminescence, the radiation which may result from the formation of excited species via chemical reactions, has several features for measurement methods: high sensitivity, specificity, continuous real-time output, and large linear response ranges. The paper briefly discusses the established methods and emphasizes the unrealized potential of this method for selective compound-specific interference-free measurements of pollutants other than NO and O_3. The reactive hydrocarbon analyzer is also discussed.

33169 Line inversion non-dispersive analyzer. Hanst, P.L.; Mani, K.V. (Environmental Protection Agency, Research Triangle Park, NC). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 158-161(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Non-dispersive infrared techniques have considerable potential for further application to ambient air measurements. Such techniques do not disperse the spectrum, but capitalize on the information in the spectrum by means of filters. By combining a gas-filled filter with a gas-filled radiation source, a very high degree of selectivity and sensitivity has been achieved. Used in the measurement of the pollutants hexane, methane, CO, hydrogen chloride, NO_2, SO_2, and ammonia, the detection system has a sensitivity of less than 1 ppM.

33170 Advances in microwave rotational spectrometry applied to gaseous pollutant measurements. Hrubesh, L.W. (Lawrence Livermore Lab., Livermore, CA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 162-163(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The most desirable feature of microwave rotational spectroscopy (MRS) for pollutant monitoring is the selectivity with which it can detect molecular species. It is highly specific for 2 reasons: the absorption of microwave radiation occurs at unique frequencies which fingerprint the presence of molecules, and the linewidth of the absorption lines is very narrow at the low gas pressures usually employed for MRS. In addition, the technique also provides quantitative information at high sensitivity; typically in the low ppM concenrations. It has the additional advantages of simplicity, fast response, totally electronic, compact, and capable of multiple pollutant detection.

33171 Application of gas chromatography to the analysis of air quality. Burgett, C.A. (Hewlett-Packard Co., Avondale, PA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 176-177(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The paper describes the applications of gas chromatographic technique, the advantages and problems, the detectors required, and several state-of-the-art systems for air quality analysis. It applies to the analysis of several air contaminates such as hydrocarbons, CO, hydrogen sulfide, SO_2, carbonyl sulfide, mercaptans, pesticides, freons, chlorinated hydrocarbons and oxidants. Recent interest has been shown in the analysis of in plant air. In addition to monitoring for solvent and organic vapors, the analysis of plastic monomers such as vinyl chloride has become important.

33172 Very sensitive CO monitor employing a gas-filter cell. Burch, D.E.; Gates, F.J. (Aeronutronic Ford, Newport Beach, GA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 178-181(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

An extensive description of the instrument that makes use of the gas-filter correlation method to provide the sensitivity and discrimination required to measure the concentration of CO in ambient air. The minimum detectable concentration of CO is approximately 0.02 ppM, about $^1/_5$ the concentration of CO in unpolluted air. The instrument is portable and can be used in remote locations. An H_2O monitor built in measures the H_2O concentration and automatically accounts for a small amount of interference by this gas.

33173 Measurement of atmospheric ammonia by mercury-sensitized luminescence. Ho. W.W.; Harker, A.B. (Rockwell International Science Center, Thousand Oaks, CA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 182-184(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

There is evidence that ammonia gas plays a significant role in the formation and stabilization of aerosols, which can contribute to the degradation of visibility as well as cause adverse human health effects. In response to the need for sensitive specific methods for its detection, a new method has been developed capable of measuring NH_3 concentrations in the ppb range for lab and field studies. This method can be applied to semicontinuous monitoring of ambient air.

33174 Status of method for the calibration of ozone monitors. Paur, R.J.; Baumgardner, R.E.; McClenny, W.A.; Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 185-188(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The Federal Reference Method for determination of the ozone concentration in synthetic atmospheres used for calibration of ozone monitors is the 1 percent neutral buffered potassium iodide (1 percent NBKI) procedure as described in the Federal Register 36 (228): Nov. 25, 1971. This calibration method is based on spectrophotometric determination of iodine released from neutral-buffered potassium iodide absorbing solutions by ozone. It is not a high precision method and has a small bias even when run under ideal conditions. Two other methods, UV photometry and gas phase titration, provide much greater pecision and appear to be more accurate. EPA is currently evaluating these methods to determine whether they will be acceptable for replacement of the current Federal Reference Method.

33175 Tropospheric residence times for several halocarbons based on chemical degradation via OH radicals. Davis, D.D. (Univ. of Maryland, College Park, MD); Watson, R.; McGee, T.; Heaps, W.; Chang, J.; Wuebbles, D. *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 189-191(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

In trying to assess the possible impact of present and future man-made halocarbons on stratospheric ozone, it is necessary that reliable residence times be known for both man-made and natural halocarbons, such as methylchloride. The purpose of the paper is to present calculated residence times for nearly a dozen halocarbon compounds, based on the assumption that the principal mode of degradation would be that resulting from attack by OH free radicals, and that the first step involving reaction with OH would be the determining step for the overall degradation process. Both assumptions appear to be fully justified.

33176 Synthesis and evaluation of potential atmospheric eye irritants. Glasson, W.A.; Heuss, J.M. (General Motors Research Labs., Warren, MI). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 208-210(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Photochemical smog is manifested by several chemical, physical, and physiological symptoms, one of which is eye irritation. A compound of the peroxyacetyl nitrate-type (PAN), peroxybenzoyl nitrate (PBzN), has been synthesized and shown to be about 200 times more powerful an eye irritant than formaldehyde. In order to further characterize atmospheric eye irritation, several irritants of the PBzN-type have been investigated.

33177 Photochemical ozone and aerosols: models of their precursor relationships with gaseous pollutants. Miller, D.F. (Columbus Labs., OH). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 214-215(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The paper reports results of a smog-chamber study of the relationship among photochemically derived ozone and aerosols and their gaseous precursors. Emphasis is given to the effects of irradiation time and the initial concentrations of nitrogen oxide and total NMHC on the development of ozone and aerosols. The models indicate that the concentrations of aerosols and ozone all go through maxima with respect to initial nitrogen oxide. At 2h, nitrogen oxide strongly inhibits formation, but this effect diminishes as irradiation time increases.

33178 Potential effect of emission control strategies on nighttime NO_2 concentrations. Kamens, R.M.; Jeffries, H.E.; Fox, D.L.; Alex-

ander, L.E. (Univ. of North Carolina, Chapel Hill). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 216-217(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Formation of nitrogen dioxide from photochemical processes has been of most concern during daylight hours. However, control of hydrocarbon emissions may create the potential for elevated nighttime and early morning NO_2 concentrations. Twenty-two hour experiments in a large outdoor smog chamber using a simulated urban hydrocarbon mixture and oxides of nitrogen produced elevated concentrations of NO_2 throughout the nighttime period. Low initial hydrocarbon, poor solar radiation or a combination of both (with same initial nitrogen oxide) could result in high nt-NO_2.

33179 Fourier-transform spectroscopic studies of gas phase ozone-olefin reactions. Niki, H.; Maker, P.; Savage, C.; Breitenbach, L. (Ford Motor Co., Dearborn, MI). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 247-250(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Some results obtained with the IR Fourier-transform interferometric spectroscopy system on the reactions of ozone with numerous organic compounds are presented, particularly olefins. An attempt to further characterize the spectra of unidentified organic products as well as to analyze all the known products quantitatively is described.

33180 Irfts spectroscopic study of the kinetics and the mechanism of the reactions in the gaseous system, HONO, NO, NO_2, H_2O. Chan, W.H.; Nordstrom, R.J.; Calvert, J.G.; Shaw, J.H. (Ohio State Univ., Columbus). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 251-253(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

The chemical transformation of the atmospheric mixture of hydrocarbons, CO, and nitrogen oxides to the irritants present in the oxidation products of the hydrocarbons, occurs through a series of chain reactions involving various active free radical species as chain carriers. One of the most important of these is the HO-radical, and the nitrous acid molecule is one of several potential sources of this radical in a sunlight-irradiated, polluted atmosphere. They build up through reactions 1 and 2: NO + NO_2 + H_2O yields 2HONO and 2HONO yields NO + NO_2 + H_2O. In turn the photolysis of HONO in sunlight may generate HO-radicals: HONO + hr yields HO + NO. The study provides the first direct measurement of the rate constants of the homogeneous reactions of 1 and 2. In view of this work it is recommended that those atmospheric scientists concerned with the chemistry within stack plumes include reactions 1 and 2 in their considerations.

33181 Mask correlation spectrophotometry advanced methodology for atmospheric measurements. Bonafe, U.; Cesari, G.; Giovanelli, G.; Tirabassi, T.; Vittori, O. (CNR, Bologna). *Atmos. Environ.;* **10**: No. 6, 469-474(1976).

An advanced methodology in mask correlation spectrophotometry is presented. By operating the instrument with its oscillating correlation mask placed in two chosen positions, a system of two equations can be solved in terms of the unknown optical depth of the gas. The methodology does not require the comparison of field instrumentation responses with laboratory calibration curves nor the in situ establishment of an absolute baseline. The relative error associated with each measurement can also be computed. Only a "normal" uv source of light need be used.

33182 Experimental studies on aerosol particle formation by sulfur dioxide. Kasahara, M.; Takahashi, K. (Kyoto Univ.). *Atmos. Environ.;* **10**: No. 6, 475-486(1976).

The formation and growth of aerosol particles of dilute sulfuric acid produced by photochemical oxidation of SO_2 (0.05 to 10 ppM, by volume) in purified air has been studied qualitatively in laboratory apparatus. The number of particles formed is strongly dependent on SO_2 concentration, relative humidity (<10 to 80%) and uv light intensity. The number concentration increases rapidly to a maximum within a few minutes after the start of irradiation and then decreases slowly during the next 10 min. Particle size increases with irradiation time and is dependent on SO_2 concentration, and on relative humidity when the SO_2 concentration is less than 0.1 ppM. In the conditions employed the volumetric rate of formation of particles ranged from 0.15 to 18.7 $\mu m^3 cm^{-3} h^{-1}$. The overall quantum yield of photochemical reaction was 8 x 10^{-3}. The oxidation rate was 0.04% h^{-1}; extrapolation of this rate to noonday sunlight in summer at latitude 35 N gives 0.7% h^{-1}.

33183 Validity of benzo (a) pyrene determination in moist warm air. De Wiest, F.; Rondia, D. (Univ., Liege). *Atmos. Environ.;* **10**: No. 6, 487-489(1976). (In French).

The influence of summer-like temperatures on losses of benzo (a) pyrene from airborne particles collected on filters has been studied during real high volume atmospheric samplings. The importance and the extreme variability of observed losses are briefly discussed. We conclude that it is necessary to develop and normalize a more adequate method to sample polycyclic hydrocarbons during hot water.

33184 Airborne Pb, Cd, Zn, and Cu concentration by particle size near a Pb smelter. Dorn, C.R.; Pierce, J.O. II; Phillips, P.E.; Chase, G.R. (Univ. of Missouri, Columbia). *Atmos. Environ.;* **10**: No. 6, 443-446(1976).

A study of airborne Pb, Cd, Zn and Cu was conducted on 2 farms: a test farm exposed to a lead smelter and associated sources of lead contamination in the New Lead Belt of southeast Missouri, and a control farm outside the lead production area. An Andersen eight-stage impactor sampler was used on both farms to collect air samples during winter, spring and summer seasons. The trace element concentrations were measured by atomic absorption spectrophotometry. The concentrations of all four elements were higher on the test farm than on the control farm in all of the three seasons. Approximately 66% of the Pb, 88% of the Cd, 73% of the Zn and 54% of the Cu was composed of particles smaller than 4.7 μm, the upper practical limit of respirable size.

33185 Numerical model of pollutant transport. Joynt, R.C.; Blackman, D.R. (Monash Univ., Victoria, Australia). *Atmos. Environ.;* **10**: No. 6, 433-442(1976).

A mathematical model of urban air pollution is described in which the pollutant is represented by fluid particles. The particles move randomly to simulate the effect of atmospheric turbulence and are also advected on the mean wind field. The concentration of pollutant at any point is given by the local density of particles. This approach provides great generality and flexibility for handling complex and time-varying emissions and atmospheric conditions. The model has been applied to sulphur dioxide in Melbourne.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

33186 (AED-Conf—76-447-002, pp v) **Dispersion of radioactive materials in air and water.** Tolksdorf, P. (Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.)); Meurin, G. 1976. (In German).

From Recent developments in the radiological environmental protection of nuclear facilities. IRS experts' talk 1976; Koeln, Germany, F.R. (28 Oct 1976).

17 figs.; 40 refs.

In REcent developments in the radiological environmental protection of nuclear facilities.

A review of current analytical methods for treating the dispersion of radioactive material in air and water is given. It is shown that suitable calculational models, based on experiments, exist for the dispersion in air. By contrast, the analysis of the dispersion of radioactive material in water still depends on the evaluation of experiments with site-specific models.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 32151

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 33118, 33129, 33269

33187 Baseline study on trace metal elution from diverse soil types. Korte, N.E.; Skopp, J.; Niebla, E.E.; Fuller, W.H. (Univ. of Arizona, Tucson). *Water, Air, Soil Pollut.;* **5**: No. 2, 149-156(Dec 1975).

Ten soils were leached with a dilute solution of $AlCl_3$, and $FeCl_3$ adjusted with HCl to pH 3.0. The effluents were analyzed for eight trace metals as well as pH, to determine the maximum contribution of the soils to the trace metal burden of the soil solution. This contribution was correlated with various soil properties to evaluate the controlling factors on the elution of certain metals. Measurable quantities of Mn, Co, Zn, Ni, Cu, and Cr were found in the soil leachates; Cd and Pb were infrequently detected. The important soil

properties describing the amounts of the elements leached were the total metal originally present, the total amount of Mn, and the percentage of free iron oxides.

33188 Mercury and selenium distribution in a defined area and in its population. Rossi, L.C.; Clemente, G.F.; Santaroni, G. (CNEN-CSN Casaccia, Rome). *Arch. Environ. Health;* **31**: No. 3, 160-165(1976).

In the Amiata Mountain area of Tuscany, Italy, a survey has examined the concentrations of mercury and selenium in the environment, in the food chain, and in human biological samples of blood, urine, and hair. This area was selected for study because of its large mineral deposits and concentration of elements, e.g., iron, copper, silver, antimony, and particularly mercury. Subjects consisted of a group with high occupational exposure to mercury vapor, a group randomly exposed to mercury dust, and a group nonoccupationally exposed to mercury. The selenium and mercury contents in all samples were determined by nondestructive neutron activation analysis, and results showed that the human metabolism of mercury is different from that of selenium and that the selenium retention in man could be influenced by the mercury intake. Furthermore, a great part of selenium introduced through the diet passes into the blood, where it is mainly associated with blood cells.

33189 Behavior of chromium soils. I. Trivalent forms. Bartlett, R.J.; Kimble, J.M. (Univ. of Vermont, Burlington). *J. Environ. Qual.;* **5**: No. 4, 379-383(1976).

Chemical behavior of Cr(III) was studied in solution, soil suspensions, and in soils of contrasting characteristics incubated at field capacity moisture. Sodium pyrophosphate, pH 4.8 NH_4OAc, and 0.1 M NaF appeared to extract organically bound Cr(III), whereas 1M HCl removed inorganic Cr hydroxides and phosphates along with some organic Cr. Pyrophosphate and HCl extracts represented quantities of Cr(III) removed; NH_4OAc and NaF extracts appeared to characterize small readily removed fractions, that is, intensity factors. Soil organic complexes of Cr(III) formed at low pH and appeared to remain stable and soluble even when soil pH's were raised to levels where the Cr would be expected to precipitate. Adsorption and solubility behavior of Cr(III) as it varied with pH and P treatments was similar to that of Al. Oxidation of Cr(III) to Cr(VI) was not demonstrated at all, even under conditions of maximum aeration and high pH.

33190 Behavior of chromium in soils. II. Hexavalent forms. Bartlett, R.J.; Kimble, J.M. (Univ. of Vermont, Burlington). *J. Environ. Qual.;* **5**: No. 4, 383-386(1976).

Adsorption and reduction of added Cr(VI) were characterized in soils with contrasting pH's, organic matter contents, and chemical and mineralogical properties. Presence of soil organic matter brought about spontaneous reduction of Cr(VI) to Cr(III), even at pH's above neutrality. Reduction did not occur in soils very low in organic matter unless an energy source was added. Cow manure added to practically organic-free Cecil B2 reduced Cr(IV) only after the pH had been lowered below 3 with HCl. The solubility of Cr(VI) in the presence of excess Al changed in a pattern remindful of orthophosphate. All of the soils, except a pH 7.8 Cca horizon material, adsorbed Cr(VI). Presence of orthophosphate prevented the adsorption of Cr(VI), presumably by competition for the adsorption sites. Consistent with this finding, KH_2PO_4 was found to be the best extracting agent for Cr(VI). It was concluded that behavior of Cr(VI), if it remains in soils, is similar to that of orthophosphate. However, unlike phosphate, Cr(VI) is quickly reduced by soil organic matter. Thus, Cr(VI) added to a soil will remain mobile only if its concentration exceeds both the adsorbing and the reducing capacities of the soil.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 33118

33191 (KURRI-TR—125, pp 22-23) **Behavior of gaseous iodine in sand.** Takahashi, K. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). 1974. (In Japanese).

From Symposium on radioiodine; Kumatori, Osaka, Japan (24 Oct 1973).

In Symposium on radioiodine.

Radioactive iodine gas was passed through 10 different sands collected at rivers and hills. The relation between the amount of the loaded gas and the amount of adsorbed gas was determined at room temperature, 50 -- 60°C, and 90 -- 100°C under humidity of $<10\%$, 50 -- 60%, and 90 -- 100%. The adsorbed iodine was expelled with dry air, then remaining iodine was washed with water, and the state of desorption was examined. Although the amount of adsorbed iodine decreased with temperature rise, the decrease was much more remarkable with the increase of humidity. The limit of adsorption was 30 -- 350 $\mu g/g$ sand or 0.2 -- 1 $\mu g/cm^2$ sand. This amount was about 1 -- 3 times as much as that of monomolecular membrane adsorption, 0.2 -- 0.3 $\mu g/cm^2$. The decrease of adsorption amount that accompanies the increase of humidity is attributable to the decrease of effective surface area of sand due to the presence of water. The transport of iodine in sand was studied by passing gaseous iodine through a glass tubing packed with sand. The distribution in the flow direction of iodine indicated that the ease of desorption depends upon the situation of adsorption. Easily desorbed case was named Henry type adsorption. Hardly desorbed case was named absorption type. Discussion is made on experimental results.

33192 (LA—6697-PR) **Environmental and radiological safety studies. Interaction of $^{238}PuO_2$ heat sources with terrestrial and aquatic environments. Quarterly report, October 1—December 31, 1976.** Waterbury, G.R. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 24p. Dep. NTIS $3.50.

The containers for $^{238}PuO_2$ heat sources in radioisotope thermoelectric generators are designed with large safety factors to ensure that they will withstand reentry from orbit and impact with the earth and safely contain the nuclear fuel until it is recovered. Existing designs have proved more than adequately safe, but the Office of the Assistant Director for Space Application of the ERDA Division of Nuclear Research and Applications continually seeks more information about the heat sources to improve their safety. The work discussed here includes studies of the effects of the heat source on terrestrial and aquatic environments to obtain data for design of even safer systems. The data obtained in several ongoing experiments are presented; these data tables will be updated quarterly. Discussions of details of the experimental testing are minimized, and they will be largely repetitive in succeeding reports to emphasize the main purpose, compilation of all usable data generated in each experiment. This compilation includes data from environmental chamber experiments that simulate terrestrial conditions, experiments to measure PuO_2 dissolution rates, soil column experiments to measure sorption of plutonium by soils, and several aquatic experiments.

SOIL

33193 Uptake of plutonium and americium by barley from two contaminated Nevada Test Site soils. Schulz, R.K.; Tompkins, G.A.; Leventhal, L.; Babcock, K.L. (Univ. of California, Berkeley). *J. Environ. Qual.;* **5**: No. 4, 406-410(1976).

Barley (Hordeum vulgare, Var. Atlas 68) plant uptake of Pu^{239}, Pu^{240}, and Am^{241} was studied using two soil samples collected from widely separated areas of the Nevada Test Site. Each area had been previously contaminated with plutonium and americium as a result of a separate high explosive (nonnuclear) detonation of a device containing plutonium. The plants were grown on 3-kg soil samples in a controlled environment chamber. The plutonium concentration ratio (plutonium concentration in dry plant tissue/plutonium concentration in dry soil) was in the order of 10^{-5} for plant vegetative material. The plutonium concentration ratio for the grain was 20 to 100 times lower than that in the vegetative material. Concentration ratios for americium were in the order of 10^{-4} for vegetative growth and 25 to 75 times lower for the grain. These results imply that americium is more available to plants than plutonium. Plutonium-bearing particles were identified in a soil sample using an autoradiographic technique and then separated from the soil samples. The Pu^{238} oxide equivalent diameters of plutonium-bearing particles could be described by a log-normal distribution function in the range of 0.2 to 0.7 μm. The actual diameters of the particles were 2 to 3 times the PuO_2 equivalent diameter. Microprobe analyses of the surface region of particles greater than 2 μm showed the following order of abundance: U, Pu is greater than O is greater than Al is greater than Si is greater than Fe is greater than Mg. Photographs obtained with a scanning electron microscope revealed that some of the particles are quite irregular and have large specific surface areas which might enhance solubility and plant uptake.

33194 Distribution of plutonium in Trinity soils after 28 years. Nyhan, J.W.; Miera, F.R. Jr.; Neher, R.E. (Los Alamos Scientific Lab., NM). Contract AT(04-3)-34. *J. Environ. Qual.;* **5**: No. 4, 431-437(1976).

The soils of four intensive study areas located along the fallout pathway of Trinity, the first nuclear detonation, were sampled to determine soil plutonium concentrations as a function of distance from Ground Zero and soil depth. About half of the Pu 239/Pu 240 in Trinity Site soils was found at the 5 to 20 cm depth in 1973 compared to total plutonium inventories found only in the upper 5 cm of soil about 20 years ago. Soil plutonium concentrations of samples collected at the same depth of each study area generally exhibited coefficients of variation is greater than 1.2. Maximum penetration depths of Pu 239/Pu 240 into Trinity Site soils were related to the presence of subsoil horizons containing carbonate accumulations and the maximum extent of rainwater penetration into

these soil profiles. Increased amounts of plutonium were associated with less than 100 μm fractions as distance from Ground Zero and soil depth increased. The less than 100 μm fraction contained 1.2 and 89 percent of the plutonium in the topsoil at the study areas located 1.6 and 44 km from Ground Zero, respectively. Total amounts of Pu 239/Pu 240 in the less than 100 μm soil size fractions also generally increased with depth; at 1.6 km from Ground Zero, this size fraction contained 1.2 percent and 13 percent of the Pu 239/Pu 240 found at the 0 to 2.5 and 5.0 to 10 cm depths, respectively. The soil plutonium data collected at Trinity Site is discussed relative to the sizes of Trinity fallout particles, setting meaningful health standards for plutonium in soils, and the distribution of plutonium in the biota of Trinity Site ecosystems.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 33193, 33194, 33209

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 31779, 31797, 31798, 31799, 31800, 32714, 32715, 32716, 32717

REGULATIONS

REFER ALSO TO CITATION(S) 33272

ENVIRONMENTAL SCIENCES, AQUATIC

REFER ALSO TO CITATION(S) 31791

BASIC STUDIES

REFER ALSO TO CITATION(S) 31769, 32719

33195 Results of an environmental research program in the Canadian Beufort Sea. Hnatiuk, J. pp 222-234 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The results of a multi-million dollar environmental research program consisting of thirty-three wildlife, biological, oceanographic, meteorological, sea ice, and oil clean-up studies related to the southern Beaufort Sea are presented. The studies were designed to provide ecological baselines, a better understanding of the physical environment, knowledge related to the consequences of a possible oil spill, and means of oil clean-up in ice-infested water. Seasonal offshore drilling in the Canadian Beaufort Sea from a floating vessel has been approved in principle and is scheduled to be undertaken during the open water period of 1976. The results of the studies will be used to recommend operating constraints to safeguard the environment and minimize any adverse impact. A unique feature of the program was its joint government-industry nature. Government agencies co-ordinated the program with considerable funding, management, and scientific input from oil industry personnel. The two-year program was completed by the end of 1975 and reports became available in early 1976. The hostile environment, scope of the studies, research methods, and study results are provided. An important phase of the program is public interface to inform northern natives, government, those with environmental concerns, and others about the program and the study results.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31859, 31860, 31861, 31862, 31863, 31864, 31865, 31866, 31883, 32199, 33118, 33119, 33120, 33121, 33124, 33126, 33129, 33150, 33188, 33217, 33273, 33275, 33276

33196 (AD—A029346) **Biodegradation of trinitrotoluene (alpha tnt) and its production isomers. Annual report Jul 74-Jul 75.** Traxler, R.W. (Rhode Island Univ., Kingston (USA). Dept. of Plant Pathology-Entomology). Jul 1975. Contract DAAG17-73-C-0276. 29p. NTIS (US Sales Only) $4.00.

High concentrations of cells of two pseudomonas isolates, IIBX, and S95YUN-5, effectively removed C(14)-labeled TNT from the reaction mixture, the C(14)-label being distributed between cells and filtrate. C(14)-activity was associated with all biochemical components of the cells obtained by solvent fractionation, and was found in chromatograms containing ninhydrin positive materials from the hydrolysis of cellular proteins. Small amounts of nitrite were observed when the reaction was carried out in nitrogen-free medium, suggesting that some of the nitro groups may be released as nitrite. (Author) (GRA)

33197 (PB—257 353) **The arctic coastal environment of alaska. Volume I. The nearshore marine environment in Prudhoe Bay, Alaska.** Feder, H.M.; Shaw, D.G.; Naidu, A.S. (Alaska Univ., College (USA). Inst. of Marine Science). Mar 1976. 167p. NTIS (US Sales Only) $6.75.

Volume I of this report considers the results of three investigations; biological, geological, and hydrocarbon chemistry conducted in Prudhoe Bay and approaches in August 1974. The three studies are closely interrelated. The investigations described in Volume I were at and near the site of a causeway construction project on the west side of Prudhoe Bay, and had as their objectives: (1) Biology-document the distribution and density of benthic animals in order to develop a benthic biological base; (2) Geology-document the grain size distributions, geochemical properties, sources of and movements of the sediment; and correlate this information with the habitat preferences of the benthic animals; (3) Chemistry-survey the kinds and amounts of hydrocarbons present in the biota and sediments. (GRA)

33198 (PB—246267) **A western regional energy development study: primary environmental impacts. Executive summary. Final report.** (Radian Corp., Austin, Tex. (USA)). 1 Aug 1975. Contract EQ4AC037. 60p. (RC—100-064-ES). NTIS $4.50.

See also Appendices, PB-246 266.

The report summarizes primary environmental impacts of 38 energy resource development scenarios: the air and water emissions, solid waste, and land requirements of a plant or process. Projected ground level ambient concentrations of pollutants are compared with federal and state standards. Scenarios include all aspects of development, including extraction, conversion, and transportation to the point of end use. (GRA)

33199 (PB—254853) **An assessment of estuarine and nearshore marine environments. Final report.** Lynch, M.P.; Laird, B.L.; Theberge, N.B.; Jones, J.C. (Virginia Inst. of Marine Science, Gloucester Point (USA)). Mar 1976. 150p. (VIMS-SRAMSOE—93-Rev). NTIS (US Sales Only).

The impact of water uses and projected water demands upon the estuarine and nearshore marine environments of the United States have been evaluated. It included a regional review of major estuarine and nearshore marine habitats, major problems impacting water and water resources, the management approach of the states, and Federal management initiatives, particularly Federal-State interactions. Estuarine resource harvest and projections are given for commercial fisheries, sport fishing, waterfowl, other wildlife harvest, bird watching, and recreational boating. Conflict areas include domestic versus foreign fleets, commercial versus sport fishing, subsistence versus commercial harvest activities. Future harvest and recreational projections include demand/supply of fisheries products, and recreation and hunting demands. Impacts of predicted water resource utilization include demand/supply, patterns of water use, seasonal and annual freshwater outflows, and effects of increased consumptive use. (GRA)

33200 Use of natural lead-210 as a heavy metal tracer in the river—estuarine system. Benninger, L.K.; Lewis, D.M.; Turekian, K.K. (Yale Univ., New Haven). pp 202-210 of In Marine chemistry in the coastal environment. New York; American Chemical Society (1975).

In streams, any dissolved metals behaving like ^{210}Pb will be scavenged by manganese or iron oxides or organic matter. By the time a large stream system like the Susquehanna encounters the estuarine zone virtually all the dissolved ^{210}Pb has been extracted on the particulate load. If metals are released from particles at the freshwater-seawater boundary, the evidence from ^{210}Pb and short-lived natural thorium isotopes is that in the estuary the metals are rapidly removed to the sediments. Thus, the flux of dissolved heavy metals from the estuary to the open ocean must be quite small. Where normal estuarine circulation pushes bottom sediments towards the continent it is obvious that very little leakage of particulate heavy metals to the deep sea will occur. Only low density or extremely fine-grained particles can escape this process and may provide a mechanism of supply of metals to the open ocean. Alternatively, it appears that transport of metal-rich topsoil via the atmospheric route as indicated by the data of Duce et al. may provide another efficient way of supplying metals to the open ocean.

33201 Pollutant aerosol deposition into southern Lake Michigan. Gatz, D.F. (Illinois State Water Survey, Urbana). *Water, Air Soil Pollut.;* **5**: No. 2, 239-251(Dec 1975).

Current estimates of pollutant aerosol input to southern Lake Michigan are based on a single calculated emission inventory and various estimates of the fraction of emissions that enter the Lake. Alternative, but still crude, estimates of urban elemental emissions and their wet and dry deposition in the lake are made here. Observed elemental concentrations in urban air are used to calculate emissions and recently measured wet and dry deposition parameters are used to calculate deposition. All available treatments conclude that atmospheric inputs of at least Fe, Pb, Ti, and V are sizable fractions of total lake input of these metals. This study suggests tentatively that (1) wet and dry inputs from the atmosphere are about equal, (2) between 3 and 15 percent of elemental pollutant emissions from Chicago and NW Indiana enter the Lake, and (3) this fraction increases with particle size.

33202 Progress in environmental monitoring and analytical methods. Skougstad, M. (US Geological Survey, Lakewood, CO). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 63-64(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

A brief discussion of Richard B. Dole's water-quality sample collecting and data, begun in 1903 until his death in 1917, which led to the establishment today of 5,000 sampling stations and the publishing annually of a series of water-quality data reports by Federal and state agencies. A few of Dole's methods are still used today, such as the Jackson candle turbidimeter (Jackson-1901), the Kjeldahl digestion procedure for organic nitrogen, and the Nessler colorimetric method for measuring ammonium-ion concentrations. Alkalinity determinations are still made with the well known color indicators, and the Mohr titremetric method has not changed in 100 years. One of the greatest changes has been in expanding the number of individual constituents determined, including many minor metallics, organic substances, and an array of radioactive isotopes and compounds. Future water analysis laboratories will rely a great deal on computers.

33203 Activated carbon adsorption of cyanide complexes and thiocyanate ion from petrochemical wastewaters. Kunz, R.G.; Giannelli, J.F. (Air Products and Chemicals, Inc., Allentown, PA). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **16**: No. 1, 94-97(1976).

From Conference of the Division of Environmental Chemistry, of the American Chemical Society; New York, New York, United States of America (USA) (4 Apr 1976).

See CONF-760447—P1.

Results of a study on activated carbon in adsorption of complexed cyanides such as divalent nickle and iron (ferrocyanide). Adsorption data are shown in Freundlich isotherm plots. Carbon adsorptive capacity was found to be in the range of 1-10 mg/g with soluble thiocyanate level of <100mg/l. Nickel removal was found to depend on the ionic state of the metal, with increasing removal as pH was raised. Ferrocyanide adsorption compared with nickleocyanide and thiocyanate only in pure solution, but contaminates in sour water probably inhibit adsorption of the ferrocyanide. Activated carbon is of limited practical value for the removal of the organic content of sour water investigated due to the nature of the short chain organics present which do not adsorb well on carbon.

33204 Evaluation of the bio surf process for the treatment of saline domestic wastewaters. Mikucki, W.J.; Poon, C.P.C. pp 294-306 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

A study was conducted to determine the feasibility and design parameters of using a Bio-Surf rotating biological contractor to treat saline domestic wastewaters. A pilot plant using a 0.5 meter Bio-Surf module was erected. Feed to the pilot plant consisted of domestic sewage to which seawater and a BOD supplement were added to meet conditions typical of an offshore site using salt-water-flush commodes. Hydraulic loading rates, susceptibility to shock loads, the efficacy of recycle as a shock remedy and other design parameters were studied. The study has demonstrated the feasibility of using the Bio-Surf waste treatment process to treat saline domestic wastewaters. Optimal loading, shock and recirculation studies as well as sludge studies are presented.

33205 Water quality bioassay using selected protozoa. I. Mills, W.L. (North Carolina Central Univ., Durham). *J. Environ. Sci. Health, Part A;* **11**: No. 7, 491-500(1976).

The suitability of certain species of protozoa as indicators of water quality has been determined. Experiments were conducted under laboratory conditions to standardize a bioassay procedure for water quality using either Paramecium caudatum, Amoeba proteus, or Euglena gracilis as the indicator organism. The bioassay, which consists of exposing the organisms to a known concentration of pollutant under laboratory conditions, followed by microscopic observation to establish the time of death, affords a reliable, convenient and inexpensive way to monitor for water quality.

33206 Distribution of heavy metals in Port Phillip Bay. Talbot, V. (Latrobe Univ., Victoria, Australia); Magee, R.J.; Hussain, M. *Mar. Pollut. Bull.;* 7: No. 3, 53-55(Mar 1976).

The distribution of cadmium, copper, iron, manganese, lead, and zinc in sediments of Port Philip Bay, Victoria, Australia was investigated, and the impact of industrial discharges studied. The pre-cultural levels for these metals are in nearly all cases far less than the post-cultural levels, especially in those sediments deposited in the last half century in the vicinity of urbanized areas.

33207 Characterization of benthic types in the lower Medway estuary, Kent. Wharfe, J.R. (Sir John Cass School of Science and Tech., London). *Mar. Pollut. Bull.;* 7: No. 9, 170-172(Sep 1976).

A number of sediment parameters, including particle size and redox potential profiles, were measured during an ecological study of the benthic invertebrate macrofauna of the lower Medway estuary, Kent. The results proved more meaningful in characterizing the sediment habitats of the benthic invertebrate fauna than did measurements on the overlying water.

33208 Distribution of short-chain halogenated aliphatic hydrocarbons in some marine organisms. Dickson, A.G.; Riley, J.P. (Univ. of Liverpool). *Mar. Pollut. Bull.;* 7: No. 9, 167-169(Sep 1976).

A number of halogenated aliphatic hydrocarbons have been determined in the various organs of three species of molluscs and five species of fish. In general, the compounds were only slightly enriched (2 to 25 times) on a dry weight basis relative to their seawater concentrations. The usual order of enrichment was found to be brain is greater than gill is greater than liver is greater than muscle. Methyl iodide was found to be the compound most strongly concentrated.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 33118, 33186, 33192, 33200

AQUATIC ECOSYSTEMS AND FOOD CHAINS

33209 (INIS-mf—3148, pp 97-105) **Data on the radiation dose to man caused by radionuclides in liquid wastes of nuclear reactors, App. 5.** van Weers, A.W. 3 Sep 1975. (In Dutch).

Published in summary form only.

In Nuclear power plants and public health, an advice by the Health Council. Influence of nuclear power plants with a total capacity of 3500 megawatts on environment and on public health in the Netherlands.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 31797, 31798, 31799, 31800, 32717, 33195

33210 Biological survey of oil platforms in the Santa Barbara channel. Bascom, W.; Mearns, A.J.; Moore, M.D. pp 27-36 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The objective of the studies reported in this paper was to obtain facts about the present status of the sea life on and near two offshore structures and compare the quantity and quality of life there now with that which lived at the tower several years ago and with nearby control sites. The undisturbed muddy and rocky bottoms that were used for controls offer conditions similar to those that would exist if the platforms had not been built. Studies of the biology of both platforms by California Fish and Game biologists in 1960 and 1970 provided historical data for comparison. Having made repeated direct observations, measurements of oceanographic parameters, precise chemical analyses of many samples, and extensive biological studies, we find that life on and around the two platforms is healthy and shows no indication of the uptake of any toxicant. Species diversity and abundance are greater than at the control sites. The number of fish now living under each platform is 20 to 50 times the number that lived in the area before construction.

33211 Laboratory biological studies: making them appropriate for predicting the effects of offshore oil and gas operations. Hester, F.J. pp 37-44 of In Eighth annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

This paper examines the worldwide problem of assessing the environmental impact of oil and gas exploration by means of laboratory studies. Widely referenced papers used in environmental impact reports are reviewed in the light of more recent studies for applicability to the oceanic environment. The review suggests that conclusions based on the older methods and studies should be revised, and that some potential effects may be less likely to occur than previously indicated.

33212 Planning and execution of offshore site investigations for a North Sea gravity platform. Hitchings, G.A.; Bradshaw, H.; Labiosa, T.D. pp 62-69 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The planning and execution of offshore investigations to collect bathymetric, topographic and geotechnical information at proposed gravity platform sites in the North Sea is discussed. In particular, platform site selection criteria, required field data, and the rational for the evaluation and selection of surveying equipment are outlined. Procedures used during actual surveys and recommendations for improving future investigations are also included.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 32704, 32728, 32736

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 32714, 32715

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

33213 (NCSR-R—10) Human reliability in complex systems: an overview. Embrey, D.E. (UKAEA National Centre of Systems Reliability, Culcheth). Jul 1976. 85p.p. NTIS (US Sales Only).

A detailed analysis is presented of the main conceptual background underlying the areas of human reliability and human error. The concept of error is examined and generalized to that of human reliability, and some of the practical and methodological difficulties of reconciling the different standpoints of the human factors specialist and the engineer discussed. Following a survey of general reviews available on human reliability, quantitative techniques for prediction of human reliability are considered. An in-depth critical analysis of the various quantitative methods is then presented, together with the data bank requirements for human reliability prediction. Reliability considerations in process control and nuclear plant, and also areas of design, maintenance, testing and emergency situations are discussed. The effects of stress on human reliability are analysed and methods of minimizing these effects discussed. Finally, a summary is presented and proposals for further research are set out.

33214 Observations of the behavior of jackrabbits (Lepus californicus) in the Mojave desert. Costa, W.R. (Barstow Unified School District, CA); Nagy, K.A.; Shoemaker, V.H. *J. Mammalogy;* **57**: No. 2, 399-402(May 1976).

Behavioral adaptations of jackrabbits to temperature extremes on the Mojave Desert were studied. It was concluded from the study that jackrabbits do not possess marked behavioral adaptations to the extremes of desert temperature. In fact, the rather mechanical, stereotyped behavior of these animals appears to force them to expose themselves to the harsh desert climate. (ERB)

33215 Alarm response of the marine mud snail, Nassarius obsoletus: specificity and behavioral priority. Stenzler, D.; Atema, J. (Boston Univ.). *J. Chem. Ecol.;* **3**: No. 2, 159-171(Mar 1977).

Nassarius obsoletus, N. vibex, and N. trivittatus were exposed to juices of conspecifics and taxonomically and ecologically related gastropod species. Conspecific juices caused the strongest alarm responses, while those from taxonomically related species (congeners) induced less pronounced responses. Juices from nonrelated species induced no alarm response with one notable exception, the strong alarm response of N. trivittatus to Urosalpinx cinerea juices. Nonrelated gastropod species induced stronger feeding responses than more closely related species. The strongest feeding responses, however, were induced by juices from nongastropod mollusks. The apparent balance between feeding attraction to less related species and alarm response to more related species was further examined by manipulating the snails' diet. Starvation resulted in a great reduction of conspecific alarm responsiveness. Following the resumption of feeding, the original responsiveness was again observed. Although the alarm response is likely an antipredator device, conclusive evidence for its effectivenes in reducing predation is lacking. One of the predators of Nassarius obsoletus which may be responsible for maintenance of an alarm response is the green crab, Carcinus maenas.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 33241, 33247

33216 Effect of Rauscher leukemia development on DNA synthesis by hematopoietic CFU-S. OKunewick, J.P.; Phillips, E.L.; Brozovich, B. (Allegheny General Hospital, Pittsburgh). *Exp. Hematol.;* **4**: 143-150(1976).

The effect of Rauscher viral leukemia on the number of colony forming cells (CFU-S) in the spleen has been measured as a function of time after virus administration. These were increased substantially after the first week, reaching a maximum at 2 weeks, after which they decreased in number. Determination of the proportion of these CFU-S which were in DNA synthesis was carried out using the in vitro ^{3}HTdR suicide technique. Within 4 hours of injection of the virus the number of spleen CFU-S which could be inactivated by in vitro ^{3}HTdR exposure increased to 20.9 percent from a normal mean value of 10.2 percent. For the next 2 weeks the proportion of CFU-S responding to tritiated thymidine exposure remained at the same value of approximately 20 percent; the change in number of surviving CFU-S roughly paralleled the change in total colony forming cells. In the third week after virus injection, the proportion of CFU-S which was inactivated by ^{3}HTdR decreased to the point where it could no longer be detected, even though the total number of CFU-S was elevated several fold over the normal. These findings indicate that infection with moderate dose levels of Rauscher virus does result in a measurable early increase in the proportion of cells in DNA synthesis. However, the failure to detect further substantial increases as the disease develops suggests that the virus of itself is not an initiator of all the steps of DNA synthesis. Rather, it would appear that it is to some degree dependent upon other aspects of normal DNA synthesis which remain under control of the cell.

33217 Inability of fish to methylate mercuric chloride in vivo. Pennacchioni, A.; Marchetti, R.; Gaggino, G.F. (Univ., Milan). *J. Environ. Qual.;* **5**: No. 4, 451-458(1976).

Experiments were designed to establish whether mercuric chloride administered to rainbow trout (Salmo gairdneri Rich.) through the gills or by way of the mouth is converted in vivo to methylmercury. The mercury was measured by atomic absorption spectrophotometry and methylmercury determinations were performed by extraction and gas chromatography. The experiments show that while mercuric chloride administered by either method increased the total mercury content of kidney, liver, intestine, and muscle tissues, no evidence was found to support the hypothesis that mercuric chloride was methylated in fish to form methylmercury.

33218 Kinetics of hormone-induced H^+ excretion. Cleland, R.E. (Univ. of Washington, Seattle). *Plant Physiol.;* **58**: No. 2, 210-213(Aug 1976).

A study has been made of the kinetics of hormone-induced H^+ excretion from peeled Avena coleoptile sections using a new, simple technique involving direct application of the pH electrode to the surface of the section. Hormone-induced H^+ excretion begins after lags and occurs at rates which are consistent with a role of H^+ in regulating cell elongation. With fusicoccin, H^+ excretion begins within the 1st minute, and an external pH of 5 (optimal for wall loosening) is reached in 5 to 8 minutes, while with auxin the lag averages 14 minutes and pH 5 is reached in 20 to 30 minutes. KCN, which inhibits cell elongation in 3 to 5 minutes, stops H^+ excretion in less than 1 minute, whereupon the external pH rises sharply. Cycloheximide stops auxin-induced H^+ excretion in 3 to 8 minutes, and the pH then rises slowly. In the absence of hormones, the pH of the extracellular solution comes to equilibrium at 5.6, but the actual pH of the wall solution is probably about 0.3 unit below this due to Donnan effects.

33219 Binding of acetyl-CoA to chicken liver pyruvate carboxylase. Frey, W.H. II; Utter, M.F. (Case Western Reserve Univ., Cleveland). *J. Biol. Chem.;* **252**: No. 1, 51-56(10 Jan 1977).

Pyruvate carboxylase from chicken liver is a tetramer whose catalytic activity is completely dependent on the presence of acetyl-

CoA. However, no direct evidence concerning the nature of the binding of the activator to the enzyme has been available. This is due in part to the instability of the enzyme and its ability to hydrolyze acetyl-CoA at an appreciable rate. The present studies on binding of the activator with the rapid flow dialysis method of Colowick and Womack ((1969) J. Biol. Chem. 244, 774-777) as modified by Klapper ((1970) Biochem. Biophys. Res. Commun. 38, 172-179) show four binding sites for acetyl-CoA. The binding dissociation constant at pH 7.2 is 13.9 μm as compared with an activation constant of 13.3 μm for the catalytic reaction at this pH. The relationship between acetyl-CoA concentration and catalytic activity is highly cooperative (n/sub H/ = 2.9). The binding process also exhibits positive cooperativity but to a lower degree (n/sub H/ = 1.9). Pyruvate carboxylase from chicken liver is rapidly inactivated and dissociated in the cold (0°). The inactive protomeric form of the enzyme has been shown to be unable to bind acetyl-CoA at 0° although the tetrameric species can do so. These results provide a plausible explanation for the catalytic inactivity of the protomer. The presence of acetyl-CoA results in an ultraviolet difference spectrum for the enzyme with a maximum at 280 nm. Half-maximal optical density difference is observed at anacetyl-CoA concentration of 9 μm, in reasonable agreement with the binding and activation constants.

33220 Dimer of a single polypeptide chain catalyzes the terminal four reactions of the L-tryptophan pathway in Euglena gracilis. Hankins, C.N.; Mills, S.E. (Univ. of California, La Jolla). *J. Biol. Chem.;* **252**: No. 1, 235-239(10 Jan 1977).

In Euglena gracilis the terminal four enzyme activities of the tryptophan biosynthetic pathway were found to be associated with a protein with an estimated molecular weight of 325,000 +- 20,000. The protein was purified approximately 2,000-fold with relatively proportional recoveries of all four enzyme activities. The purified material was homogeneous by the criteria of analytical disc gel eletrophoresis and gel isoelectric focusing. Disc gel electrophoresis after denaturation with sodium dodecyl sulfate gave a single protein band with a molecular weight of 155,000 +- 5,000. Disc gel electrophoresis in 8m urea also gave rise to a single protein band. We interpret these results as evidence for a single species of subunit. The pathway in Euglena is the only one known to the present in which the terminal enzyme, tryptophan synthase, is not a separate molecular species.

33221 Co-use of retention time and bandwidth measurements in evaluations of nucleotide pools by ion-exchange chromatography. Khym, J.X.; Bynum, J.W.; Volkin, E. (Oak Ridge National Lab., TN). *Anal. Biochem.;* **77**: No. 2, 446-463(Feb 1977).

In our studies involving the metabolic functions of free nucleotides in mammalian cells, we have found that certain less common nucleoside phosphates and nonnucleotide components, such as the nucleosides and bases, coelute with nucleotides such as AMP, GMP, CDP, ADP, etc. in our high-resolution anion-exchange procedure. This type of interference was discovered by the rigorous comparison of both retention times and bandwidths of solute bands from unknown mixtures and authenic compounds which had been chromatographed under identical conditions. To eliminate this interference, we carry out a fractionation of acid-soluble components by chromatography on polyacrylamide-gel columns. This preliminary step allows nucleotides to be separated as a group from bases and nucleosides. Examples of such combined chromatography are given, and the use of this technique in obtaining valid quantitations for nucleotide pools is demonstrated.

33222 Spin-label studies on the aqueous regions of phospholipid multilayers. Keith, A.D.; Snipes, W.; Chapman, D. (Pennsylvania State Univ., University Park). *Biochemistry;* **16**: No. 4, 634-641(22 Feb 1977).

Water-soluble spin labels were used to study dimyristoyllecithin (DML) phospholipid multilayers. Previous studies report that there is a "bound" water region associated with dimyristoyllecithin containing about 10 molecules of water per phospholipid, a "trapped" water region located between the lamellae containing approximately 11 molecules per phospholipid, and a "free" water region external to the lamellae. The results of this investigation show that certain water-soluble spin-label molecules have their motional properties differentially modified by these three water environments. Furthermore, the labels also reveal the onset of lipid-phase transitions even though they have high water solubility. A phosphate-containing spin label demonstrated strong anisotropic motion in the lipid-water system above the phase transition but not below. The addition of cholesterol to the DML-water system removed the anisotropic motion of 2,2,6,6-tetramethyl-4-phosphopiperidine-N-oxyl (Tempo-phosphate) and obscured the detection of bound, trapped, and free water. In addition to the charge-charge interactions between Tempophosphate and DML, two other spin labels were used both in the charged and uncharged states. 2,2,6,6-Tetramethyl-4-aminopiperidine-N-oxyl (Tempamine) in the charged state showed extremely strong anisotropic motion. PCA was analyzed at pH values where the carboxyl group was protonated and unprotonated. The resulting interaction was different at the two pH values. The usefulness of this approach in studying solute behavior when freezing occurs and potential studies involving aqueous regions of cytoplasm are considered.

CYTOLOGY

33223 (LA-UR—76-2462) Laser backscattering measurements on biological cells: preliminary results. Salzman, G.C.; Price, B.J.; Hiebert, R.D.; Mullaney, P.F.; Visser, J.W.M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 26p. (CONF-761132—1). Dep. NTIS $4.00.

From Workshop on separation of normal and neoplastic cells; Amsterdam, Netherlands (9 Nov 1976).

A cell flow-system instrument is described in which the light scattered by a cell as it passes through a focused helium-neon laser beam is detected simultaneously at 26 angles between 0° and 4.4° and at 176° with respect to the laser beam axis. The usefulness of backscatter in distinguishing among variously sized plastic microspheres is demonstrated. Preliminary results with mouse bone marrow cells are also discussed.

33224 Kinetic analysis of splenic erythropoiesis in mice under prolonged hypoxic stress. Markoe, A.M.; OKunewick, J.P.; Schiffer, L.M. (Allegheny General Hospital, Pittsburgh). *Exp. Hematol.;* **1**: 340-349(1973).

The cytokinetics of C3H mouse spleen cells during compensatory erythropoiesis were evaluated by a double-labeling autoradiographic method. The total contribution of the spleen to erythropoiesis was also determined utilizing normal and splenectomized mice and evaluating the ensuing peripheral blood changes during hypoxia. Only the basophilic and the definitely erythroid spleen cell populations expanded markedly in response to hypoxia, reaching plateau levels during the first week of exposure. During this time, the apparent DNA synthesis time (T/sub s/) and cell cycle time (T/sub c/) of the basophilic population remained unchanged, but a reduction of these parameters occurred in the erythroid population. T/sub s/ fell from 7.2 to 5.5 h or less and T/sub c/ decreased proportionately, since the labeling index remained unchanged. We concluded that the shortening of T/sub s/ and T/sub c/ in some spleen cell populations may be one of the mechanisms subserving the ultimate peripheral blood reticulocytosis and increased hematocrit. However, the spleen of C3H mice apparently functions only in an accessory capacity since the splenectomized animal appears to be capable of full compensation to the erythropoietic stress of prolonged hypoxia.

33225 Physiology and plastic fine structure of deetiolating Lemna minor. Frick, H.; Jones, R.F. (State Univ. of New York, Stony Brook). *Can. J. Bot.;* **54**: No. 15, 1819-1826(1 Aug 1976).

During the 12-h lag period in chlorophyll accumulation after the onset of white-light illumination of Lemna minor etiolated for 35 days, a rapid increase in visible fronds per culture occurred. This new frond production then assumed a log-linear rate of increase, and total protein per unit fresh weight came to parallel the rate of increase in fresh weight per plant. The ribosomal RNA content of 45-day-etiolated plants was deficient in 23S and 16S species compared with green plants. The prolamellar bodies of etioplasts were either tightly or loosely paracrystalline within the same cell; they were without extended perforate lamellae, which developed during far-redlight illumination even while prolamellar bodies persisted. The development of chloroplasts in deetiolating L. minor was typical of other higher plants. The developmental sequence in green Lemna included proplastid to deeply stacked granal chloroplast within several millimeters. Plastid profiles suggestive of division configurations occurred only in primordial cells of green and etiolated plants. The relatively small numbers of plastids in any given stage of differentation may account for the sensitivity of plastid development to inhibitors of protein and nucleic acid synthesis.

GENETICS

33226 Patterns of molecular variation. II. Associations of electrophoretic mobility and larval substrate within species of the Drosophila mulleri complex. Richardson, R.H.; Smouse, P.E.; Richardson, M.E. (Univ. of Texas, Austin). *Genetics;* **85**: No. 1, 141-154(Jan 1977).

Electromorphic variation among populations of Drosophila mojavensis, D. arizonensis and D. longicornis was examined for seven genetic loci. The average electrophoretic mobility for a population was used as the metric. D. mojavensis and D. arizonensis use larval substrates in different parts of their geographic ranges, while D. longicornis is more narrowly restricted to different species of the cactus Opuntia in different localities. There is marked electromorphic variation among populations of either D. mojavensis or D. arizonensis, and the bulk of this variation is accounted for by differences in laval substrate. There is somewhat less variation among populations of D. longicornis, and only a moderate portion of

this is accounted for by larval substrate differences. There appears to be an association between the taxonomic diversity of the larval substrates and the electromorphic diversity of the Drosophila populations utilizing those substrates. Evidence is reviewed that suggests physiological mechanisms for these possibly adaptive associations.

METABOLISM

REFER ALSO TO CITATION(S) 33216

33227 Accelerated clearance of exogenously administered erythropoietin by mice with Rauscher viral leukemia. OKunewick, J.P.; Erhard, P. (Allegheny General Hospital, Pittsburgh). Contract AT(11-1)-3097. *Cancer Res.;* **34**: 917-919(May 1974).

Both the endogenous plasma erythropoietin levels and the rate of plasma clearance of injected erythropoietin have been investigated in SJL/J mice that had been rendered leukemic by the injection of Rauscher virus. The results show an elevated level of endogenous erythropoietin coupled with an accelerated rate of erythropoietin clearance. These results are inconsistent with the hypothesis previously suggested by other workers that erythropoietin production is impaired by Rauscher leukemia. As an alternative, it has been proposed that as a result of the leukemia both erythropoietin production and clearance are accelerated to such a degree that very little reserve production capacity remains to allow for additional hormone synthesis in response to the stimuli of extreme anemia or bleeding.

33228 Axenic culture and uptake of dissolved organic substances by the marine nematode, Rhabditis marina Bastian. Tietjen, J.H.; Lee, J.J. (City Coll. of New York). *Cah. Biol. Mar.;* **16**: 685-693(1975).

Monoxenic Rhabditis marine were freed from the associated bacteria (Pseudomonas sp.) by aseptic washing and transfer through anti-biotic-containing media. R. marina was maintained axenically on Grace's Insect media and a marine salt base. The addition of casamino acids, hemoglobin and crude natural materials rich in lipids were found to stimulate growth and reproduction. Lipid rich materials such as TEM (triethyleneamine) and TWEEN 80 were consistently stimulatory, and replaced the amino acid mixture when supplemented with whole egg powder. Mixtures of various fatty acids were able to replace the undefined lipid mixtures. It is suspected that R. marina has fewer fatty acid synthetic abilities than other free-living nematodes which have been studied. The uptake of several dissolved organic substances by R. marina was examined. No uptake of ^{14}C-labelled organic substances from solution was observed, even at high (20 mM) concentrations. The addition of small (0.5-1.0 μ) latex microspheres to the experimental medium, however, resulted in uptake of label. This suggests that the major nutritional pathway for R. marina is probably through particulate material, such as bacteria and perhaps algae.

33229 Photosynthetic rates of sun versus shade leaves of Hyptis emoryi Torr. Nobel, P.S. (Univ. of California, Los Angeles). *Plant Physiol.;* **58**: No. 2, 218-222(Aug 1976).

Leaves on a bush of Hyptis emoryi Torr, varied in length from less than 1 cm when development occurred in full sunlight (e.g. 40 Mjoules m^{-2}) to over 7 cm when the total daily solar irradiance was less than 3 Mjoules m^{-2}. The 1-cm sun leaves were 3-fold higher than the 7-cm shade leaves in chlorophyll per unit area, mesophyll thickness, and the internal to external leaf area ratio (A/sup mes//A). The higher A/sup mes//A caused a 1.2-cm leaf to have a 3-fold lower CO_2 liquid phase resistance than did a 7.1-cm leaf. Large thin shade leaves captured photosynthetically active radiation effectively (less than 7 percent passed through), but were not adapted to full sunlight. Specifically, when a 6.9-cm leaf was placed at 910 w m^{-2} for 30 min, its temperature exceeded that of the air by nearly 8°C. For the common daytime air temperatures above 30°C for this desert shrub, large shade leaves would have temperatures far in excess of that optimum for photosynthesis for H. emoryi, 29 to 32°C.

33230 Metabolism as a function of water potential in air-dry seeds of charlock (Sinapis arvensis L.). Edwards, M. (Univ. of Nottingham, Eng.). Contract AT(11-1)-1338. *Plant Physiol.;* **58**: No. 2, 237-239(Aug 1976).

A new method is described for studying the metabolism of air-dry seeds. An initial pulse of $^{14}CO_2$ was supplied to seeds maintained in air at controlled low water potentials for 6 months. Seeds were also infiltrated with 2-^{14}C-acetate and with ^{14}C-L-leucine at 0°C, redried rapidly at 0°C, and maintained at controlled low water potentials for 4 to 6 weeks. The metabolism of the air-dry seeds was a function of the water content of the tissues, which was in equilibrium with the water potential at the seed surface. The fixation of $^{14}CO_2$ and the utilization of 2-^{14}C-acetate increased exponentially with water content. The incorporation of ^{14}C-L-leucine into protein increased linearly with water content. Metabolism was not reduced to a low rate except in air-dry seeds at the lowest water potentials (-1716 to -762 bars) with 4 to 6 percent water.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 33277

MEDICINE

33231 Comparative study of alkaline phosphatase activity in lymphocytes, mitogen-induced blasts, lymphoblastoid cell lines, acute myeloid leukemia, and chronic lymphatic leukemia cells (N-alkaline phosphatase/thiophosphoric acid thioesters). Neumann, H. (Weizmann Inst. of Science, Rehovoth, Israel); Klein, E.; Hauck-Granoth, R.; Yachnin, S.; Ben-Bassat, H. *Proc. Natl. Acad. Sci. U.S.A.;* **73**: No. 5, 1432-1436(May 1976).

Alkaline phosphatase [orthophosphoricmonoester phosphohydrolase (alkaline pH optimum), EC 3.1.3.1] purified from a Burkitt lymphoma cell line (Daudi) and Moloney-virus-induced murine leukemia (YAC) showed unique catalytic properties in substrate specificity and inhibition by cysteamine-S-phosphate. It migrated on polyacrylamide gel electrophoresis in a single activity band. Alkaline phosphatase with similar properties was found in several human lymphoblastoid cell lines, in chronic lymphatic leukemic cells, in organs of leukemic mice, and in sera of patients with certain lymphoproliferative disorders. The unique kinetic properties of this enzyme were established using two kinds of substrate, namely, the monoesters of orthophosphoric acid (Type I) and the S-substituted monoesters of thiophosphoric acid (Type II). The enzyme catalyzed the hydrolysis of Type I, but failed to hydrolyze Type II. The enzyme probably interacts directly either in catalysis or in binding with the —P—O— or —P—S— bonds. Thus, in these respects it differs from the established enzymatic mechanism of other known alkaline phosphatases, and therefore can be considered a new enzyme. This enzyme was designated N-alkaline phosphatase. N-alkaline phosphatase was absent in untreated and mitogen-stimulated human blood lymphocytes, in murine lymph nodes, and pig thymus (even after mitogen stimulation), and in blast cells of acute myeloid leukemic patients. The appearance of N-alkaline phosphatase only in certain types of proliferating lymphocytes and in the sera of patients with lymphoproliferative disorders may be exploited as a cell marker and as a diagnostic tool.

33232 Differential temperature integrating diagnostic method and apparatus. Doss, J.D.; McCabe, C.W. (to Energy Research and Development Administration). US Patent 3,960,138. 1 Jun 1976. Filed date 6 Jan 1975. 6p.

PAT-APPL-539,130.

A method and device for detecting the presence of breast cancer in women by integrating the temperature difference between the temperature of a normal breast and that of a breast having a malignant tumor. The breast-receiving cups of a brassiere are each provided with thermally conductive material next to the skin, with a thermistor attached to the thermally conductive material in each cup. The thermistors are connected to adjacent arms of a Wheatstone bridge. Unbalance currents in the bridge are integrated with respect to time by means of an electrochemical integrator. In the absence of a tumor, both breasts maintain substantially the same temperature, and the bridge remains balanced. If the tumor is present in one breast, a higher temperature in that breast unbalances the bridge and the electrochemical cells integrate the temperature difference with respect to time. 8 claims, 3 figures.

33233 Apparatus for proton radiography. Martin, R.L. (to Energy Research and Development Administration). US Patent 3,986,026. 12 Oct 1976. Filed date 14 Nov 1975. 8p.

PAT-APPL-632,030.

An apparatus for effecting diagnostic proton radiography of patients in hospitals comprises a source of negative hydrogen ions, a synchrotron for accelerating the negative hydrogen ions to a predetermined energy, a plurality of stations for stripping extraction of a radiography beam of protons, means for sweeping the extracted beam to cover a target, and means for measuring the residual range, residual energy, or percentage transmission of protons that pass through the target. The combination of information identifying the position of the beam with information about particles traversing the subject and the back absorber is performed with the aid of a computer to provide a proton radiograph of the subject. In an alternate embodiment of the invention, a back absorber comprises a plurality of scintillators which are coupled to detectors. 10 claims, 7 drawing figures.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 32930

33234 Changes in spleen cellularity and erythrocyte accumulation following Rauscher virus infection in the mouse. Markoe, A.M.; OKunewick, J.P. (Allegheny General Hospital, Pittsburgh). *Scand. J. Haematol.;* **10**: 273-281(1973).

The nature of the relationship of the spleen enlargement effected by Rauscher virus infection of SJL/J mice has been investigated with reference to cell proliferation in the spleen and to splenic red blood cell pooling and anaemia. The gross splenic nucleated cell content was found to increase linearly with spleen weight. The ratio of total spleen cells to nucleated spleen cells was identical at a value of 1.75 to 1 for both normal and virus-infected mice even though in the latter some spleen sizes were as high as 30 times normal. On a per milligram basis, the average splenic accumulation of ^{59}Fe-labelled normal red blood cells by normal mice was approximately twice as great as by 18-day leukaemic mice, even though the leukaemic spleens contained a greater fraction of the injected label. Anaemia was seen to develop shortly after injection of the virus, reducing the haematocrit to values of less than 40 by two weeks. Compensatory increase in reticulocyte number did not occur until after the major fall in venous haematocrit had already been achieved. Peripheral white blood cell counts increased with time after virus injection and these correlated positively with spleen size, the relation being logarithmic. The data confirm the assumption that splenomegaly is a direct result of the cellular proliferative effects of Rauscher virus rather than a consequence of increased red blood cell pooling in the spleen.

33235 Radionuclide generators: current and future applications in nuclear medicine. Yano, Y. (Univ. of California, Berkely). pp 236-245 of In Radiopharmaceuticals. Subramanian, G. (ed.). New York; Society of Nuclear Medicine, Inc. (1975).

From International symposium on radiopharmaceuticals; Atlanta, Georgia, USA (12 Feb 1974).

See CONF-740203—.

The progress of nuclear medicine has been marked by the developments in instrumentation and in radiopharmaceuticals, including radionuclide generator systems which provide short-lived daughters without the expense of frequent shipments. It does not appear likely that there will be any significant change in the predominant role of /sup 99m/Tc in the immediate future. The most fruitful area of research may well be in the development of new radiopharmaceuticals labeled with /sup 99m/Tc. A promising area of development is new radioisotope generators to provide ultrashort-lived nuclides for dynamic studies of blood flow through the brain, heart, and other organs.

33236 Sterile kits for the preparation of radiopharmaceuticals: some basic quality control considerations. Briner, W.H. (Duke Univ., Durham, NC). pp 246-253 of In Radiopharmaceuticals. Subramanian, G. (ed.). New York; Society of Nuclear Medicine, Inc. (1975).

From International symposium on radiopharmaceuticals; Atlanta, Georgia, USA (12 Feb 1974).

See CONF-740203—.

Quality control concepts involved in the formulation of radiopharmaceutical kits, as well as all other radiopharmaceuticals, are meant to protect both the patients who receive these products and the practitioners of nuclear medicine who use these products in their practice. These concepts include the adequacy of site and facilities in which these products are formulated, the level of training and experience of personnel responsible for the formulation of the products, quality assurance procedures employed to monitor the acceptability of products, and, finally, a professional dedication to excellence in all these matters. The absence of any of these in a nuclear medicine or radiopharmaceutical program will result in almost certain disaster.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 33267

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 33231

33237 Carcinogenic and mutagenic N-nitroso compounds. Lijinsky, W. (Oak Ridge National Lab., TN). pp 193-217 of In Chemical mutagens. Vol. 4. Hollaender, A. (ed.). New York; Plenum Publishing Corp. (1976).

N-nitroso compounds have been known since about 1860 when the preparation of dimethylnitrosamine was first described. They can be formed easily by interaction of secondary or tertiary amino compounds with nitrous acid or other nitrosating agents. Their toxic effect has been alluded to for some time, but their specific action was not described until 1954, when Magee and Barnes reported toxic liver injury by dimethylnitrosamine in man and rats and carcinogenesis by the same compound in rats. The first report of mutagenicity of a nitroso compound referred to methylnitrosonitroguanidine. Since then there has been growing interest in the toxicology of N-nitroso compounds and in their chemistry and biochemistry. In spite of all of this activity, however, there is no satisfactory explanation of the biological actions of N-nitroso compounds.

33238 Alarm substance of the marine mud snail, Nassarius obsoletus: biological characterization and possible evolution. Atema, J.; Stenzler, D. (Boston Univ.). *J. Chem. Ecol.;* 3: No. 2, 173-187(Mar 1977).

The gastropod snail Nassarius obsoletus shows a dramatic self-burial response to the presence of crushed conspecifics. After it was shown that this burial alarm response could be reliably replicated in laboratory tests, a further characterization of the alarm substance was undertaken. Dilution experiments showed a very high response threshold resulting in a short effective radius of the substance in agreement with earlier field reports. Longevity experiments showed that the substance had lost some activity after 16 hr standing over marsh mud in seawater at room temperature; it became inactive after 24 hr. Superthreshold concentration in seawater was not necessary to keep the snails buried: Mud apparently provides an adsorption surface which can remain a stimulus source for previously unalarmed snails, and snails tend to remain buried after a short exposure to alarm substance, even when given a fresh environment. The substance is present in the snail's blood and tissues and is passively released. A potential natural predator capable of such release is Carcinus maenas, the green crab. Predator odor alone did not cause burial alarm responses. Preliminary chemical analysis indicates that the substance is water soluble, heat stable, and of high apparent molecular weight (over 100,000). A comparison with fish alarm substance and response is made in a discussion of the possible evolution of chemically triggered alarm responses. It is argued that N. obsoletus may have developed an alarm response to an existing nonspecific substance rather than a true alarm pheromone.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 33275, 33276

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 32724, 32725, 32726, 33184, 33272

33239 Evaluation of the hazards caused by air pollution. Balatskii, O.F. pp 187-191 of In Problemyi kontrolya i obespecheniya chistoty atmosfery. Berlyanda, M.E. (ed.). Leningrad; Gidrometeoizdat (1975). (In Russian)

From All-Union seminar on problems of the control and guarantee of the purity of the atmosphere; Moscow, Union of Soviet Socialist Republics (USSR) (Apr 1973).

See CONF-730497—.

Means of decreasing industrial emissions are examined. Methods for the determination of the hazards caused by these emissions from metallurgical installations are also examined. The hazards were calculated for the case when pollution control equipment is used and when it is not used. It was determined that in Georgia the installment of air pollution equipment would cost 4.5 million rubles and the return on the capital investment of 24 million rubles would be somewhat greater than 5 years.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 33272

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

33240 Search for an adenine photoproduct in DNA. Rahn, R.O. (Oak Ridge National Lab., TN). *Nucleic Acids Res.;* 3: No. 4, 879-890(1 Dec 1975).

Poly(d[^{14}C]A), p(dA)$_2$, and [^{14}C]adenosine-labeled DNA were irradiated at 254 nm with fluences up to 50 J/m^2, and then following formic acid hydrolysis at 170°C were subjected to paper chromatography using a butanol:water: acetic acid (80:30:12) solvent system. For poly(dA), up to 25 percent of the radioactivity appeared as fluorescent material located in the Rf 0.21 to 0.29 region. The hydrolysate of the purified photoproduct, p(dA)$_2$*, isolated from irradiated p(dA)$_2$ by DEAE chromatography also had an Rf of 0.29

as well as an absorbance maximum at 310 nm. In all cases studied, however, the photoproduct yield in the Rf 0.29 region for native DNA was less than 2 percent. Denaturation of the DNA appeared to enhance the yield slightly, although no pronounced peak in this region of the chromatogram was discerned. Mechanistic studies indicate that the yield of the adenine photoproduct in poly(dA) is favored by base stacking, has a singlet excimer as a precursor, and is quenched by hydrogen bonding to a pyrimidine. It is concluded that the yield of the adenine photoproduct in both native and denatured DNA is considerably less than in poly(dA) and in all probability does not represent a biologically significant product.

33241 Photoreactivating enzyme from Escherichia coli: appearance of new absorption on binding to ultraviolet irradiated DNA. Wun, K.L.; Gih, A.; Sutherland, J.C. (Univ. of California, Irvine). *Biochemistry;* **16**: No. 5, 921-924(8 Mar 1977).

The photoreactivating enzyme, PRE, monomerizes pyrimidine dimers in DNA in a light requiring reaction (lambda greater than 300 nm). However, the purified PRE from E. coli has no well-defined absorption band for lambda greater than 300 nm. Using absorption difference spectroscopy, we show that when PRE is mixed with ultraviolet-irradiated DNA, new absorption appears in the spectral region required for catalysis. There is a concomitant decrease in the absorption of the mixture for wavelengths less than 300 nm. The hyperchromicity for lambda greater than 300 nm is true absorption, not an artifact due to light scattering. Both the hyperchromicity (lambda greater than 300 nm) and hypochromicity (lambda less than 300 nm) can be reversed by irradiation at 365 nm with identical first-order kinetics. We estimate the molar extinction coefficient of the new absorption to be 6900+- 1400 at 350 nm. We conclude that the PRE from E. coli does not possess a distinct "chromophore" which by itself is entirely responsible for the absorption of photoreactivating light. Instead, new absorption results when PRE binds its substrate, dimer-containing DNA.

RADIATION EFFECTS ON CELLS

33242 (ORO—4761-5) **Repetitious nature of repaired DNA in mammalian cells. Progress report, June 1, 1976—February 28, 1977.** Meltz, M.L. (Southwest Foundation for Research and Education, San Antonio, Tex. (USA)). Feb 1977. Contract EY-76-S-05-4761. 50p. Dep. NTIS $4.00.

Progress is reported on studies of DNA repair in cultured mouse L fibroblasts, human diploid fibroblasts, and cultured human lymphoblastoid cell lines. Data are included on the effects of methyl methanesulfonate treatment, uv light, and age of cell donors on repair replication of DNA.

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 33254

33243 (ERDA-tr—222, pp 134-137) **Role of endogenous substances in creating a higher radioresistance background. Report 8. Investigation of effects of radioprotectors on levels of biogenous amines in bone marrow cells.** Goncharenko, E.N.; Graevskaya, E.E.; Gorskaya, T.G. (Moscow State Univ.). 1976. Translated from Radiobiologiya; 16: No. 3, 431-434(1976).

In Radiobiology.

Levels of serotonin and histamine in mouse bone marrow were tested after administration of serotonin and after incubation of bone marrow cells with these substances. The radiosensitivity of bone marrow cells was determined according to colony-forming capacity. Recipient mice were exposed to 700 R x-rays and a suspension of bone marrow cells was exposed to 100 R radiation. Results indicated that cellular radiosensitivity is related to specific changes in biochemical processes including an increase in endogenous serotonin and histamine content. (HLW)

33244 Effects of erythropoietin in vitro on spleen colony-forming cells. Van Zant, G.; Goldwasser, E. (Univ. of Chicago). *J. Cell. Physiol.;* **90**: No. 2, 241-251(Feb 1977).

Erythropoietin (epo) added to liquid cutures of mouse bone marrow cells affected both the numbers of spleen colony-forming cells (CFU) in the cultures and the types of spleen colonies formed from these cells in irradiated hosts. Epo caused an increase in the numbers of CFU detected in cultures on the second day; this effect persisted through day 10, with the maximal increase occurring on the seventh day. The magnitude of the rise on day 7 was proportional to the amount of epo added. The increase in spleen colonies found with cells cultured in the presence of epo was due solely to erythroid colonies. After seven days in culture without epo, there was a peak of cells that formed non-erythyroid colonies. This peak did not appear when the cells were cultured in the presence of epo.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

33245 Role of DNA sequences in genetic recombination in the ISO-1-cytochrome c gene of yeast. II. Comparison of mutants altered at the same and nearby base pairs. Moore, C.W.; Sherman, F. (Univ. of Rochester, NY). *Genetics;* **85**: No. 1, 1-22(Jan 1977).

X-ray-induced mitotic recombination rates and spontaneous meiotic recombination rates have been determined in two-point crosses of various defined cyc1 mutants of the yeast Saccharomyces cerevisiae. All but one of the 17 cyc1 mutants chosen for this study contained either the addition, deletion or substitution of single base-pairs located within a defined segment of the gene that corresponds to the 11 amino acid residues at the amino terminus of iso-1-cytochrome c; approximately half of these mutants had alterations of the AUG initiation codon, some at the same base pair. Up to 66-fold differences in x-ray-induced recombination rates were observed when the same cyc1 mutant was crossed to cyc1 mutants having different alterations in the AUG initiation codon; over a ten-fold difference was observed in series of homologous crosses involving mutants with different changes at the same base-pair. Recombination rates that were associated with specific cyc1 mutants co-segregated with the particular alleles following meiosis, and comparable recombination patterns were also observed for independently isolated, identical mutations. With the mutants used in this study, the frequencies of meiotic recombination did not differ as markedly, suggesting a dissimilar dependence on specific DNA sequences for these two modes of recombination. These disproportionalities of recombination rates suggest that the nature of the mismatched bases influences the recombination process, but not in a way that can be simply interpreted.

RADIOSTERILIZATION OF MEDICAL SUPPLIES

33246 Control and detection of microbial contamination in short-lived radiopharmaceuticals. Cooper, J.F.; Avis, K.E. (Univ. of Tennessee, Memphis). pp 254-257 of In Radiopharmaceuticals. Subramanian, G. (ed.). New York; Society of Nuclear Medicine, Inc. (1975).

From International symposium on radiopharmaceuticals; Atlanta, Georgia, USA (12 Feb 1974).

See CONF-740203—.

We have described the cleaning and sterilization of glassware and utensils, the choice of a sterilization procedure for the product, and the establishment of an appropriate working environment as essential conditions for assuring the quality of parenteral radiopharmaceuticals. A systematic approach to sterility and pyrogen testing, even when done retrospectively, documents the adequacy of the production procedure. When optimum conditions are met, the Limulus test for endotoxin js a sensitive, convenient test that may be completed before patient administration of short-lived radiomedications.

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

33247 (ERDA-tr—222, pp 145-149) **Comparative study of 7S globulin subunits in cotton seeds.** Tuichiev, A.V.; Usmanov, R.M. (Inst. of Biochemistry, Tashkent). 1976. Translated from Radiobiologiya; 16: No. 3, 440-443(1976).

In Radiobiology.

Results are presented of a comparative study of quantitative changes in proportion and physicochemical properties of subunits of 75 globulin of cotton seeds following presowing gamma radiation. It was concluded that the subunits of gobulin differed in electrophoretic mobility, molecular weight, sedimentation coefficient, quantitative content, and uv absorption spectra. (HLW)

33248 (ERDA-tr—222, pp 158-160) **Inhibition of additional DNA synthesis at the G_2 phase used to modify radiation injuries to Crepis capillaris L. chromosomes induced at the G_1 phase.** Azatyan, R.A.; Voskanyan, A.Z.; Zakaryan, M.S.; Akif'ev, A.P. (Inst. of Experimental Biology, Erevan). 1976. Translated from Radiobiologiya; 16: No. 3, 449-451(1976).

In Radiobiology.

Dry C. capillaris seeds were exposed to x-rays and sprouted in water. Thirty-two hrs later the seedlings were placed in FUDR solution and colchicine for 3 hrs. The additional number of chromosome aberrations occurring in the presence of FUDR was due to simple chromated breaks. About 40 percent of the potential changes induced in seeds by x-radiation change into a latent state and can be expressed with inhibition of additional DNA synthesis at the premitotic stage. (HLW)

33249 (ERDA-tr—222, pp 182-184) **X virus infection of chronically γ-irradiated potato plants.** Zezyukin, A.I.; Lysenkov, V.I.;

Shcherbakov, V.K. (Moscow Dept. of the All-Union Scientific Research Inst. of Plant Growing). 1976. Translated from Radiobiologiya; 16: No. 3, 467-469(1976).

In Radiobiology.

The effects of chronic gamma irradiation on accumulation of x virus in potato plants were studied. Plants exposed to low dose rates were found to be more resistant to infection than nonirradiated ones. Results of these studies are compared with those of studies on tobacco mosaic virus. (HLW)

33250 (ERDA-tr—222, pp 185-188) **Localized changes in electron irradiated potato tubers.** Serebrenikov, V.S.; Simakov, E.A. (Scientific Research Inst. of Potato Growing, Moscow). 1976. Translated from Radiobiologiya; 16: No. 3, 469-471(1976).

In Radiobiology.

Potato tubers were exposed to gamma radiation and fast electrons. Five days later incorporation of ^{35}S-methionine was determined and 20 days later incorporation of ^{32}P was determined. Tables are presented to show effects of radiation on growth and development and uptake of ^{35}S and ^{32}P. These processes were inhibited by radiation and a localized effect was observed in the case of electron irradiation. (HLW)

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 32152, 33117

33251 (AED-Conf—76-447-005) **Recent developments in the radiological environmental protection of nuclear facilities. IRS experts' talk 1976. Lecture manuscripts.** (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (Germany, F.R.)). 1976. vp. (In German). TIC.

Separate abstracts were prepared for individual papers. (ERB)

33252 (BNWL-SA—5992) **Evaluating the effects of low-level chronic exposures.** Gilbert, E.S. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-1830. 18p. (CONF-761023—4). Dep. NTIS $3.50.

From 2. ERDA statistical symposium; Oak Ridge, Tennessee, United States of America (USA) (25 Oct 1976).

Problems involved in assessing health effects of chronic low-level exposures to environmental contaminants are reviewed. This problem is illustrated by a study of health effects of occupational exposure to ionizing radiation at Hanford. Hanford was established in the early forties as an installation for plutonium production. Since this time, over 33,000 workers have been employed, many in jobs involving some exposure to radiation. Yearly records of this exposure, as well as occupational data, are maintained for all such employees. The yearly exposures are measured in rems of ionizing radiation able to reach critical organs of the body. Even for those who routinely work in radiation zones, yearly readings seldom exceed one or two rems. Methods for assessing directly the health effects of continuing relatively small doses of radiation over a number of years are discussed that should be applicable to evaluating exposures to other industrial and environmental contaminants.

33253 (KR—153) **Literature survey: health effects of radiation.** Tveten, U.; Garder, K. (Institutt for Atomenergi, Kjeller (Norway)). [nd]. 66p. NTIS (US Sales Only).

49 references.

This report was originally written as a chapter of a report entitled 'Air pollution effects of electric power generation, a literature survey', written jointly by the Norwegian Institute for Air Research (NILU) and the Institutt for Atomenergi (IFA). (INIS RN242406). A survey is presented of the health effects of radiation. It has not, however, been the intention of the authors to make a complete list of all the literature relevant to this subject. The NILU/IFA report was meant as a first step towards a method of comparing the health effects of electric power generation by fission, gas and oil. Consequently information relevant to quantification of the health effects on humans has been selected. It is pointed out that quantitative information on the health effects of low radiation and dose rates, as are relevant to routine releases, does not exist for humans. The convention of linear extrapolation from higher doses and dose rates is used worldwide, but it is felt by most that the estimates are conservative. As an example of the use of the current best estimates, a calculation of normal release radiation doses is performed.

33254 (NTIS/PS—76/0612) **Radiation effects on cells and chromosomes (a bibliography with abstracts). Report for 1964—Aug 1976.** Crockett, P.W. (National Technical Information Service, Springfield, Va. (USA)). Aug 1976. 131p. NTIS (US Sales Only).

Supersedes NTIS/PS—75/551.

Reports on the effects of radiation on cell physiology, chemistry, and genetics are cited. Mechanisms of radiotherapy on cancerous cells are discussed. (This updated bibliography contains 126 abstracts, 24 of which are new entries to the previous edition.) (GRA)

VERTEBRATES

33255 **Leukemic transformation of donor spleen cells following their transplantation into supralethally irradiated mice with pre-existing viral leukemia.** Kuhnert, P.M.; OKunewick, J.P.; Erhard, P. (Allegheny General Hospital, Pittsburgh). *Exp. Hematol.;* 2: 328-335(1974).

Fialkow et al. previously reported leukemia induction in donor-type cells after treating patients for acute lymphoblastic leukemia with total-body irradiation and hematopoietic cell transplantation. Utilizing a murine model and paralleling their treatment protocol, we have documented that induction of leukemia can occur in normal donor cells transplanted into Rauscher viral leukemic mice at 0, 1 and 2 days after irradiation. The induction of leukemia in the grafted cells was verified by: the occurrence of splenomegaly; and secondary spleen cell transplants, whereby the secondary donors were transplanted mice still alive at 30 days and the secondary recipients were normal unirradiated mice. The spleen weights of the grafted leukemic mice were found to be significantly greater than those of the controls and all secondary recipients that received spleen cells from the primary grafted leukemic mice also died of leukemia. Verification that the regenerating hematopoietic tissue was from donor (males) and not host source (females) was accomplished by spleen chromosome preparations taken from randomly selected mice at 14 and at 30 days after cell transplantation. In these preparations, the Y chromosome was clearly distinguishable on the basis of size, shape, and differential staining. The data indicate that induction of leukemia after whole-body irradiation and hematopoietic cell transplantation can occur in immunologically matched donor cells when a viral agent is present and that the incidence of this induction is not affected by a time delay between irradiation and transplant.

33256 (ERDA-tr—222, pp 138-140) **Taurine content in tissues of rats exposed to ionizing radiation.** Akhalaya, M.Ya.; Bogatyrev, G.P.; Kudryashov, Yu.B.; Yartsev, E.I. (Moscow State Univ.). 1976. Translated from Radiobiologiya; 16: No. 3, 434-436(1976).

In Radiobiology.

Acute radiation sickness was induced in rats by whole-body x-radiation and graphs are presented to show taurine levels in the stomach, liver, spleen, and small intestine. Phasic changes in taurine levels were observed in radiosensitive rat tissues; the phases of decrease of taurine levels corresponded to phases of hyperexcretion. (HLW)

33257 (ERDA-tr—222, pp 141-144) **Esterases of rat blood serum, liver and small intestinal mucosa following γ-radiation.** Surinov, B.P. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1976. Translated from Radiobiologiya; 16: No. 3, 437-440(1976).

In Radiobiology.

Rats were exposed to gamma radiation in doses of 350 to 15,000 rad and organs were perfused with saline to remove blood. The liver and small intestinal mucosa were homogenized; blood serum and supernatant were submittd to electrophoresis. The activity of esterase fractions was determined. Differences in esterase content in tissues following irradiation were observed. Results are shown by means of graphs and the significance of results is discussed. (HLW)

33258 (ERDA-tr—222, pp 154-157) **Effects of taurine on insulin secretion in isolated pancreatic tissue of intact and irradiated rats.** Dokshina, G.A.; Silaeva, T.Yu. (Tomsk State Univ., USSR). 1976. Translated from Radiobiologiya; 16: No. 3, 446-449(1976).

In Radiobiology.

Rats were exposed to 700 rad x-radiation and were given taurine intraperitoneally. On the 12th postradiation day the animals were killed and pancreatic tissue was extracted and insulin activity was determined. Results indicated that restoration of pancreatic activity takes place, when taurine is administered following irradiation, not only through the adenylate cyclose system, but via other routes of restoration of hormone secretion by islet tissue. (HLW)

33259 (ERDA-tr—222, pp 161-165) **Effects of ionizing radiation on lymphoid cell populations in mice.** Yarilin, A.A.; Polushkina, E.F.; Filatov, P.P. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1976. Translated from Radiobiologiya; 16: No. 3, 451-455(1976).

In Radiobiology.

Changes in the proportion of T and B lymphocytes were investigated following exposure to gamma radiation; the link was assessed between depression of the immune response and change in reactivity of T and B lymphocytes and their proportions in lymphoid organs. A table is presented to show changes in size of spleen cell populations, composition, and immune reactivity after exposure to radiation. (HLW)

33260 (ERDA-tr—222, pp 166-169) **Effects of linoleic acid hydroperoxides on bone marrow lesions and death of irradiated mice.** Gurovich, A.V.; Deev, L.I.; Kudryashov, Yu.B. (Moscow State Univ.). 1976. Translated from Radiobiologiya; 16: No. 3, 455-458(1976).

In Radiobiology.

In this work, we investigated the effects of linoleic acid hydroperoxides (LAP) on resistance of mice to x-irradiation. We determined survival rate and increase in frequency of chromosomal aberrations in dividing bone marrow cells as criteria of severity of radiation lesion. The data confirm the hypothesis that PUFA hydroperoxides have radiosensitizing activity, and they warrant the assumption that the higher death rate of irradiated animals with preradiation administration of hydroperoxides is apparently due to more severe injury to bone marrow cells.

33261 (ERDA-tr—222, pp 170-174) **Effectiveness of active immunization of irradiated animals with E. coli enhanced by administration of homologous blood.** Dobronravova, N.N.; Klemparskaya, N.N.; Il'in, V.I. 1976. Translated from Radiobiologiya; 16: No. 3, 458-461(1976).

In Radiobiology.

Previous studies showed that subcutaneous administration of homologous blood 2 hrs after injection of antigen increased the effectiveness of immunization in control mice and mice exposed to gamma radiation with immunization 1 day after irradiation. The present study was conducted to investigate the effectiveness of hemostimulation of the immune response at different stages of radiation sickness. Results showed a consistency between the extent of hemostimulating and desensitizing effects of the schedules followed in the different groups of animals. (HLW)

33262 (ERDA-tr—222, pp 175-178) **Quantitative patterns of injury and recovery of blood following single and chronic external γ-irradiation.** Zapol'skaya, N.A.; Borisova, V.V.; Yakovleva, N.G. (Leningrad Scientific Research Inst. of Radiation Hygiene). 1976. Translated from Radiobiologiya; 16: No. 3, 462-464(1976).

In Radiobiology.

Two groups of rats were used. One group was exposed once to 300 R gamma radiation while the other was exposed to daily irradiation at the rate of 5R/day for 2 yrs. Observations were made on the morphological composition of peripheral blood and incidence of aberrant mitoses in hematopoietic cells of bone marrow. Results showed that rates of recovery of peripheral blood cells and hematopoietic cells with aberrant mitoses were about 50 percent lower with chronic irradiation than with single exposure. (HLW)

33263 (ERDA-tr—222, pp 179-181) **Adverse effect of high polymer heterologous DNA on survival of irradiated animals.** Shutko, A.N.; Shatinina, N.N. (Central Scientific Research Inst. of Roentgenology and Radiology, Leningrad). 1976. Translated from Radiobiologiya; 16: No. 3, 465-467(1976).

In Radiobiology.

Rats were exposed to x-radiation in doses of 600 to 1200 rad and later were given subcutaneous injections of unadulterated and degraded DNA. The data on survival rates indicated that depolymerization of DNA results in increase of positive properties in most experimental variants, indicating that there is a link between origin of the adverse effect and polymerism of the preparation. (HLW)

33264 **Delayed formation of chromosome aberrations in mouse pachytebne spermatocytes treated with triethylenemelamine (TEM).** Generoso, W.M.; Krishna, M.; Sotomayor, R.E.; Cacheiro, N.L.A. (Oak Ridge National Lab., TN). *Genetics;* **85**: No. 1, 65-72(Jan 1977).

Induction of chromosome aberrations in pachytene spermatocytes of mice by 2 mg/kg TEM was compared with induction by 400 R x rays. These doses induced comparably high dominant lethal effects in pachytene spermatocytes of mice. Cytological analysis at diakinesis-metaphase I stage showed that whereas 76.4% of the cells treated with x rays at pachytene stage had aberrations, the frequencies observed in two TEM experiments were only 0.8 and 2.2%. On the other hand, 5% of the progeny from TEM-treated pachytene spermatocytes were found to be translocation heterozygotes. This is the first report on the recovery of heritable translocations from treated spermatocytes of mice. The aberration frequencies observed for TEM in diakinesis-metaphase I were much too low to account for all the lethal mutations and heritable translocations. Thus, the formation of the bulk of aberrations induced by TEM in pachytene spermatocytes was delayed—a marked contrast to the more immediate formation of x-ray-induced aberrations. It is postulated that the formation of the bulk of TEM-induced aberrations in pachytene spermatocytes and in certain postmeiotic stages occurs sometime during spermiogenesis, and not through the operation of postfertilization pronuclear DNA synthesis.

INVERTEBRATES

33265 **Aedes.** Rai, K.S. (Univ. of Notre Dame, IN); Hartberg, W.K. pp 311-345 of In Handbook of genetics. Vol. 3. King, R.C. (ed.). New York; Plenum Publishing Corp. (1975).

Studies on genetics, cytogenetics, and genetic control of mosquitoes belonging to the genus Aedes are reviewed. Emphasis is placed on the yellow fever mosquito, Aedes aegypti. Some topics discussed are as follows: morphological mutants; biochemical mutants; genetics of insecticide resistance; effects of radiation on the cell cycle; chromosome ultrastructure; chromosomal rearrangements; mosquito data bank; and World Health Organization International Reference Center for Aedes. (HLW)

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 32155, 33252

ANIMALS

33266 (ERDA-tr—222, pp 150-153) **Protective effects of DNA preparations on survival and yield of 8-azaguanine resistant mutations in irradiated cultures of Chinese hamster cells.** Kuznetsova, N.N.; Feoktistova, T.P. 1976. Translated from Radiobiologiya; 16: No. 3, 444-446(1976).

In Radiobiology.

Hamster cell cultures were exposed to 600 R x-radiation; DNA from calf thymus was added to the cultures 1 hr before irradiation and 3 days later. Different preparations of DNA had different effects on survival and yield of mutants. The DNA preparations had different molecular weights, but this could not be related to differences in protective effects. (HLW)

MAN

REFER ALSO TO CITATION(S) 32603

PLANTS

REFER ALSO TO CITATION(S) 33193, 33194

CHEMICALS METABOLISM AND TOXICITY

MICROORGANISMS

REFER ALSO TO CITATION(S) 31865, 33205, 33207

33267 **Influence of carbon—nitrogen ratio on the chlorination of microbial aggregates.** Characklis, W.G.; Dydek, S.T. (Rice Univ., Houston, TX). *Water Res.;* **10**: No. 6, 515-522(1976).

Experiments were conducted with attached microbial films in a continuous flow reactor to determine the response of the film to hypochlorite treatment as a function of influent substrate concentration, influent carbon—nitrogen ratio (C/N) and shear force at the slime-water interface. Experiments were also conducted in batch systems with suspended organisms grown at varying C/N. Results were obtained regarding the relationship of bactericidal action to slime destruction. Comparison of experiments with HOCl and Hg^{2+} indicates that bactericidal efficiency does not influence slime destruction. Destructive effects of hypochlorite oxidation were noted by measuring decrease in solids concentration of bacterial cultures. (auth)

PLANTS

33268 **Sensitivity of tobacco to chromium from mechanical draft cooling tower drift.** Parr, P.D.; Taylor, F.G. Jr.; Beauchamp, J.J. (Oak Ridge National Lab., TN). *Atmos. Environ.;* **10**: No. 6, 421-423(1976).

The effect of chromium from cooling tower drift on vegetation was assessed at the Oak Ridge Gaseous Diffusion Plant using Kentucky Burley 21 tobacco plants (Nicotiana tabacum) which is noted for its sensitivity to chromium. Potted tobacco plants were placed along the axis of the most frequent wind direction at 15, 200, 600, and 1400 m from the cooling towers. Plants were harvested at one-week intervals for seven weeks from each distance and assessed for total plant biomas, leaf biomass, leaf area, general vigor determinations and chromium concentrations. There was an inverse relationship between foliar chromium concentrations and distance from the towers. Associated with high chromium concentration was a 75% inhibition of leaf growth.

33269 **Determination of copper, iron, nickel, and sulphur by x-ray fluorescence in lichens from the Mackenzie Valley, Northwest Territories, and the Sudbury District, Ontario.** Tomassini, F.D.; Puckett, K.J.; Nieboer, E.; Richardson, D.H.S.; Grace, B. (Laurentian Univ., Sudbury, Ont.). *Can. J. Bot.;* **54**: No. 14, 1591-1602(15 Jul 1976).

X-ray fluorescence was adapted to the analysis of 22 terricolous lichen species from 14 sites in the Mackenzie Valley, Northwest

Territories, and 7 species from the Sudbury District of Northern Ontario. X-ray fluorescence (XRF) proved to be faster and exhibited better sensitivity and reproducibility than conventional analytical techniques; also, the samples were not destroyed in the analysis. Procedural details of the XRF method are given. The levels of copper, iron, nickel, and sulphur in Arctic lichens were similar to those found in lichens growing on the periphery of the Sudbury pollution zone but very much lower than in specimens nearer the nickel smelter. A linear relationship between concentration and the reciprocal of the distance from the Copper Cliff smelter was confirmed for the occurrence of these four elements in samples collected along a 60-mi NNW transect.

INVERTEBRATES

REFER ALSO TO CITATION(S) 33208

VERTEBRATES

REFER ALSO TO CITATION(S) 33208, 33217, 33264

33270 Respiratory tract deposition of smoke particles using a nasal bypass device. Kendrick, J.; Rubin, I.B.; Creasia, D.A.; Maddox, W.L.; Guerin, M.R.; Nettesheim, P. (Oak Ridge National Lab., TN). *Arch. Environ. Health;* **31**: No. 3, 131-135(1976).

In order to avoid nasal absorption, an intralaryngeal cannula was tested as a device for bypassing the nose in delivering smoke into the lungs of hamsters. The intralaryngeal cannula increased lung deposition of radiolabeled smoke particles twofold to threefold over that in nosebreathing controls. Stabilization of respiration (absence of avoidance reaction), rather than prevention of nasal absorption of smoke, was demonstrated to be the cannula's major mechanism of action. Although suitable for acute exposures, the device is of limited use for chronic exposures that require daily insertion of the cannula during an extended period of time.

33271 Increased life span and decreased weight in hamsters exposed to cigarette smoke. Wehner, A.P.; Olson, R.J.; Busch, R.H. (Battelle Pacific Northwest Labs., Richland, WA). *Arch. Environ. Health;* **31**: No. 3, 146-153(1976).

Five groups of fifty-one 2-month-old male Syrian golden hamsters received three 10-minute exposures to cigarette smoke per day, 5 days per week, for the duration of their lives. Three of the groups were also chronically exposed to aerosols of chrysotile asbestos, cobalt oxide, and nickel oxides, respectively. The fourth group received twelve weekly injections of 0.25 mg of diethylnitrosamine. The smoke-exposed groups lived significantly (P is less than .01) longer than their sham-exposed cohorts and untreated controls. Their mean body weights were significantly (P is less than .01) lower than in the sham-exposed groups. The hypothesis is proposed that delayed onset of amyloidosis and lower body weight in the smoke-exposed hamsters may have been responsible for their increased life spans. It is hypothesized that cigarette smoke affected the immune system of the animals, resulting in retardation of amyloidosis, a frequent cause of death in hamsters.

33272 Cadmium background content in meat, liver, and kidney from cattle and its consequences to cadmium tolerance levels. Kreuzer, W. (Univ., Munich); Sansoni, B.; Kracke, W.; Wiszmath, P. *Chemosphere;* **5**: No. 4, 231-240(1976).

From International conference on heavy metals in the environment; Toronto, Ontario, Canada (27 Oct 1975).

The natural background of cadmium content in meat, liver and kidney from 287 cattle from a nonpolluted area in the subalpine region of Bavaria has been analyzed during the period from 1972 to 1975. The cadmium content in meat was always below the detection limit of 0.005, in liver between less than 0.005 to 1.65 (median 0.050) and in kidney 0.008 to 1.95 (median 0.229) ppM cadmium in fresh weight. The cadmium contents are discussed and compared with preliminary suggestions for cadmium tolerance levels and their consequence for food inspection.

33273 Toxic effects of hexavalent chromium on brook trout (Salvelinus fontinalis) and rainbow trout (Salmo gairdneri). Benoit, D.A. (Environmental Protection Agency, Duluth). *Water Res.;* **10**: No. 6, 497-500(1976).

Exposing brook trout to various concentrations of chromium [Cr(VI)] for up to 22 months (including reproduction) significantly increased alevin mortality at 0.35 mg Cr l^{-1} and retarded growth of young brook trout at the lowest concentration tested (0.01 mg CrI^{-1}). Eight month exposures of rainbow trout significantly increased alevin mortality at 0.34 mg CrI^{-1} and also retarded growth at the lowest concentration tested (0.10 mg CrI^{-1}). Exposures of brook trout lasting 22 months showed, however, that growth was only temporarily affected, and therefore, it was not used as an end point to measure the affects of chromium on either species. Reproduction, and embryo hatchability of brook trout were unaffected at Cr(VI) concentrations that affected survival of newly hatched alevins. The maximum acceptable toxicant concentration (MATC) for brook and rainbow trout exposed to Cr(VI) in water with a hardness of 45 mg l^{-1} (as $CaCO_3$) and a pH range of 7 to 8 lies between 0.20 and 0.35 mg CrI^{-1}. The 96-h LC_{50} for brook and rainbow trout was 59 and 69 mg CrI^{-1}, respectively; therefore, the application factor (MATC/96-h LC_{50}) for both species lies between 0.003 and 0.006. (auth)

33274 Effects in the liver of methylene chloride inhaled alone and with ethyl alcohol. Balmer, M.F.; Leach, L.J.; Yuile, C. (Univ. of Rochester, NY). *Am. Ind. Hyg. Assoc. J.;* **37**: No. 6, 345-352(Jun 1976).

When high concentrations of methylene chloride in combination with high concentrations of ethanol were inhaled for one day by guinea pigs, the extent of the hepatic damage induced suggested an antagonism between the effects of the two agents. However, exposure for five days to approximately 500 ppM of methylene chloride plus high concentrations of ethanol suggested ethanol may potentiate the effects of methylene chloride.

33275 Accumulation of inorganic mercury from sea water by the plaice, Pleuronectes platessa L. Pentreath, R.J. (Fisheries Radiobiological Lab., Lowestoft, Eng.). *J. Exp. Mar. Biol. Ecol.;* **24**: No. 2, 103-119(15 Oct 1976).

The accumulation of inorganic mercury from sea water by plaice eggs, larvae, and adult fish has been studied using $^{203}HgCl_2$ as a tracer. The isotope was rapidly accumulated and the levels of accumulation have been related to stable element concentrations. High concentration factors were attained by many organs, but the distribution of the ^{203}Hg was markedly different from that of the stable element. Whereas the largest fraction of the body burden of mercury is contained by muscle, only a slow rate of accumulation into this tissue was observed. In addition, the mercury in fish muscle is of the methyl form: no evidence for the methylation of the tracer was obtained.

33276 Accumulation of organic mercury from seawater by the plaice, Pleuronectes platessa L. Pentreath, R.J. (Fisheries Radiobiological Lab., Lowestoft, Eng.). *J. Exp. Mar. Biol. Ecol.;* **24**: No. 2, 121-132(15 Oct 1976).

The accumulation of organic mercury from sea water by plaice eggs, larvae and adult fish has been studied using $CH_3{}^{203}HgCl$ as a tracer. The isotope was rapidly accumulated, the largest fraction being taken up by muscle tissue. High concentration factors were attained by many internal organs, particularly blood, spleen, and kidney. Longer biological half-times than previous estimates with $^{203}HgCl_2$ were obtained: the possible consequences of inorganic mercury accumulated from sea water being excreted at the rate for methylmercury have been calculated.

MAN

REFER ALSO TO CITATION(S) 31765, 31921, 33188, 33239

33277 Delayed appearance of tracer lead in facial hair. Rabinowitz, M.; Wetherill, G.; Kopple, J. (Univ. of California, Los Angeles). *Arch. Environ. Health;* **31**: No. 4, 220-223(1976).

Three adult men were fed ^{204}Pb—a rare, stable isotope of lead—daily for about 100 days. Simultaneous blood and facial hair measurements of this tracer and of total lead concentrations were made by mass spectrometric isotope dilution analysis. Although the blood showed an immediate response to the intake of the tracer, the facial hair showed a more gradual response and a delay of approximately 35 days. Since the pattern of appearance of lead in hair does not appear to represent a simple time delay of blood lead concentration, the existence of a physiological pool of lead fed by the blood and giving rise to the content in hair is suggested. Hair lead values should therefore, be interpreted as the integral of the blood lead values over the mean life of this intermediate pool—about 100 days.

33278 δ-aminolevulinic acid dehydratase in low level lead exposure. Wada, O.; Takeo, K.; Yano, Y.; Ono, T.; Nagahashi, M.; Seki, H. (Tokyo Univ.). *Arch. Environ. Health;* **31**: No. 4, 211-215(1976).

No statistically significant correlation was observed between log delta-aminolevulinic acid dehydratase (ALAD) activity and blood lead levels (Pb-B) in rural or urban habitants (P is greater than .5 and P is greater than .1, respectively) in whom no occupational source of lead was known. However, when the values of the two groups were pooled, there was a fairly good negative correlation ($r = -0.509$, P is less than .01). Stepwise correlation coefficient analysis indicated the existence of a threshold value of Pb-B (around 15 μg/100 ml) below which ALAD activity has no orderly relationship with the Pb-B. In contrast with married couples, parents and their children showed a remarkably high interrelationship in values of ALAD. It is concluded that in low level lead exposure primarily genetic factors influence the activity of ALAD and, thus, ALAD is useful for the evaluation of lead exposure only when the lead level is higher than the threshold.

33279 **Health problems associated with nitrites and nitrosamines.** Lijinsky, W. (Oak Ridge National Lab., TN). *Ambio;* 5: No. 2, 67-72(1976).

Nitrites are formed by reduction of nitrate and are present in the environment at low concentrations. Nitrites can react with secondary and tertiary amino compounds to form N-nitroso compounds, a broadly acting and potent group of systemically acting carcinogens. These reactions taking place in the human stomach could constitute an important source of carcinogens. Restrictions on the amount of residual nitrite in cured meats and fish processed with nitrite would reduce exposure of man to these carcinogens.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 33120, 33121

33280 (AD—A032179) **Thermal responses to high-frequency electromagnetic radiation fields. Interim report 1 Jul-1 Sep 75.** Frazer, J.W.; Merritt, J.H.; Allen, S.J.; Hartzell, R.H.; Ratliff, J.A. (School of Aerospace Medicine, Brooks AFB, Tex. (USA)). Sep 1976. 19p. (SAM-TR—76-20). Q 02/MF/A01.

Monkeys were exposed to fields of 1000, 750, and 500 mW/sq cm. at 26 MHz in a coaxial transmission line for 6 hours. An immediate rise in skin and rectal temperature, with subsequent cooling, was noted. Rectal temperature reached an equilibrium after about 1.5 hours of exposure. This equilibrium was maintained throughout the remainder of the explosure period. Thermoregulatory mechanisms activated as a result of exposure to even the highest power (1000 mW/sq cm.) appear adequate to dissipate the imposed heat load. (Author) (GRA)

33281 (AD—A032367) **Sources and biological effects of nonionizing electromagnetic radiation. Master's thesis.** Sosnicky, A.P. (Naval Postgraduate School, Monterey, Calif. (USA)). Sep 1976. 74p. Q 04/MF/A01.

This thesis is designed to provide an insight into potential biological effects on humans resulting from exposure to nonionizing electromagnetic radiation emitted by communications and radar equipment. The spectrum considered extends from the extremely low frequency band, which may be employed for communicating with submerged submarines, through the microwave band, which is utilized for satellite communications and radars. The different views of the Soviet bloc and the Western nations are presented. A near term safety measure, the use of protective garments, is recommended while debate continues. The underlying intent of this thesis is to provide a compact document which can be used to introduce telecommunications managers and other interested personnel to the uses, characteristics, and possible hazards of this valuable portion of the electromagnetic spectrum. (Author) (GRA)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 32719

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 32067

33282 **Geology for planning in the Redlands area, Mesa County, Colorado.** Hart, S.S. (comp.). Denver; Colorado Geological Survey (1976). vp. $7.00.

Four maps of the Redland and Grand Junction areas present the geology, mineral resources, geologic hazards, and permeability of the areas. (DLC)

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 33112

33283 **Seismicheskaya energiya i metody ee opredeleniya. (Seismic energy and methods for its determination).** Kogan, S.Ya. Moscow; Izdatel'stvo Nauka (1975). 152p.

Spherical and axially-symmetric sources of seismic oscillations are considered. The energy emitted by the seismic oscillations as seismic waves is determined. A general method of calculating the seismic energy at a source is enunciated. By means of this method a relation is established between the seismic energy, and the main source parameters and the properties of the medium in which the source is acting. (SJR)

33284 **Drought and earthquake.** Keng, C.K. *K'o Hsueh Shih Yen;* No. 10, 26-27(Oct 1976). (In Chinese).

A statistical study is reported on the relationship between drought and earthquake. It was found that of the 69 large earthquakes of more than 6 richter scale recorded throughout the history of China from 231 BC to 1971, 58 to 84 percent of them were preceded from one to three years by serious droughts. In conclusion, the author stresses the significance of utilizing climatic anomaly as a means of earthquake prediction.

33285 **Thermal and mechanical structure of the upper mantle: a comparison between continental and oceanic models.** Froidevaux, C. (Univ., Paris); Schubert, G.; Yuen, D.A. *Tectonophysics;* 37: No. 1-3, 233-246(5 Jan 1977).

Temperature, velocity and viscosity profiles for coupled thermal and mechanical models of the upper mantle beneath continental shields and old ocean basins show that under the continents, both the tectonic plate and the asthenosphere, are thicker than they are beneath the oceans. The minimum value of viscosity in the continental asthenosphere is about an order of magnitude larger than in the shear zone beneath oceans. The shear stress or drag underneath continental plates is also approximately an order of magnitude larger than the drag on oceanic plates. Effects of shear heating may account for flattening of ocean-floor topography and heat flux in old ocean basins.

MAGMATISM, VOLCANOLOGY, AND IGNEOUS PROCESSES

REFER ALSO TO CITATION(S) 32257, 32258, 32261, 32262, 32270, 33285, 33295

33286 **Dinamika vzaimodeistviya magmy s porodami. (Dynamics of interaction between magma and rocks).** Sharapov, V.N.; Golubev, V.S. Novosibirsk, USSR; Izdatel'stvo Nauka (1976). 237p.

By virtue of an original solution of Stephan's problem, the dynamics of the process of granitization and convection melting was studied with filtration of volatiles from magma, assimilation of rocks by melting and dissolution in magma, and effects of osmotic distillation and transvaporization. Here, the dynamics of magma intrusion is discussed during the motion of the melt front by free convection and hydromechanical flow in rock channels. Petrochemical criteria are suggested in order to distinguish allochthonous and autochthonous plutons. A summary of data is given on the diffusion of components in silicate melts, viscosity, and other physical properties of magma.

33287 **Heat flow of the Beregovian ore region (Transcarpathia).** Gordienko, V.V.; Kutas, R.I.; Zharnikova, R.S. (Inst. of Geophysics, Kiev). *Dopov. Akad. Nauk Ukr. RSR. Ser. B;* No. 7, 583-585(Jul 1976). (In Ukrainian).

The heat flow distribution in the region was studied in detail. The analysis of the detected disturbances permitted the regional anomalies to be associated with the block structure of the region, and local ones, with the deposits of sulphide ores and manifestations of sulphide mineralization as well as with the effect of thermal waters.

33288 (LA-tr—77-8) **Magnetic measurements and volcanic activity: Soufriere 1976.** Robach, F.; Bof, M.; Rey-Giraud, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Jan 1977. Translation of CEA Note LETI/MA 76-952 FR/AL. 20p. Dep. NTIS $3.50.

A study of Soufriere, a volcano on Gaudeloupe, by magnetic measurements showed that the volcanic manifestations and the effects measured by high sensitivity differential magnetometry are correlated. To simply things, the volcano can be compared to a disease and the measurement to a medical thermometer. Its reading increases on the days preceding an important manifestation (phreatic eruption). It then drops. The correlation is quite sharp, and even such weak manifestations as ash emissions are perceived. Independently of any precise understanding of the physical mechanism, this technique supplies a valuable indication at present for those who wish to venture into the summit zone. The "measure" of the risk of eruption is available early in the morning. If the weakness of actual volcanic phenomena is taken into account, bringing out a useable magnetic expression is of great future promise for Soufriere and volcanos of the same type. In the meantime, and from a more scientific point of view, we have to note the weakness of the measured effects: order of magnitude, 1 gamma = 10^{-5} Oersted or approximately 2.5×10^{-6} of the terrestrial magnetic field; and the size of the phenomena associated with electromagnetic induction, which limits the possibilities of a delicate analysis in the field. The most natural interpretation of the observations is based on piezomagne-

tism. The principle itself of phreatic manifestations, the dynamics of the phenomenon, observed ground deformations and the order of magnitude of the effect are favorable in this sense.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 31796, 31808, 33087

33289 Zero phase seismic sections. Shugart, T.R.; Barry, K.M. pp 457-467 of In Eight annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Digital shaping filters are designed for the purpose of maximizing the resolution in seismic data while minimizing the adverse effects that inverse filters usually have on the signal-to-noise ratio. Knowledge of the basic propagating seismic wavelet shape is required. In marine data, this is most often obtained by analysis of seafloor reflections. These shaping filters provide the additional advantages of reflection polarity clarification and precision in reflection onset timing. The results of applying these filters are illustrated by examples of real marine seismic data from several parts of the world.

33290 Stratigraphic resolution potential of marine seismic data. Neidell, N.S.; Lindsey, J.P.; Hilterman, F.J. pp 469-475 of In Eight annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

Marine seismic data offer immediate opportunities for markedly increased stratigraphic resolution owing to seismic modeling and other recent developments. Most of the initial benefits derived from simulating seismic exploration over subsurface models were directed toward structural interpretive applications. Current seismic model studies are providing insights which are principally of stratigraphic nature. For example, the resolution inherent in the usual band of seismic frequencies under appropriate conditions was discovered to be at least three times greater than previously conceived. Additionally, quantitative methods for utilizing marine wavelet processed data are beginning to emerge. Such progress at this early stage of effort suggests more significant results to follow.

33291 Display parameters of marine geophysical data. Sheriff, R.E.; Farrell, J. pp 477-486 of In Eight annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

The display of marine geophysical data has an important influence on the ability of an interpreter to recognize and understand interrelationships among data elements. For seismic record sections, the proper choice of such parameters as horizontal and vertical scales, the number of tra ces per horizontal unit, the trace amplitude color, and black/white bias may aid the interpreter in his search for significant structural and stratigraphic features. Continuity of events can be emphasized with variable area displays. Superimposing a wiggle plot on the variable area aids the interpreter in detailed work. Vertical exaggeration also emphasizes reflection alignment but loses some details of wave shape. Apparent information content is altered by varying display parameters. The choice of these parameters, therefore, has a critical effect on the ability of the display to communicate information to the interpreter.

33292 Wave-equation migration: two approaches. Larner, K.; Hatton, L. pp 487-503 of In Eight annual offshore technology conference. Vol. II. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P2.

A conventional stacked seismic section displays data only as a passing wave-field recorded at selected points on the earth's surface. In regions of complex geology, this display may bear little resemblance to a cross section of subsurface reflectors. Migration is the technique used to transform the wave-field of a seismic section into a reflectivity display. As such it should be possible to relate any seismic migration method to a solution of the scalar wave equation—the assumed mathematical description of wave propagation in the earth's subsurface. Such solutions can be derived from either an integral or differential form of this equation. For example, a refinement of the conventional method of summing along diffractiion hyperbolas is founded on the integral solution. In recent years, integral solutions have been complemented by solutions of differential forms of the wave-equation. After discussing fundamental assumptions required in the two migration approaches, this paper focuses primarily on comparison migrations of both synthetic data and of marine and land profiles. For good data of modest dip, the two approaches produce results which are remarkably similar despite their very different conceptual bases and realizations. This outcome is very encouraging as it increases confidence in the rationale behind migration. For poorer data of modest dip, the solutions based on differential forms of the scalar wave-equation have noticeably superior S/N compared with their integral form counterparts. The seismic trace spacing (receiver group interval) is found to play different, but fundamental, roles in governing the accuracy and quality of both types of migration.

33293 Free fall seismic capsule for seismicity and refraction work. Prothero, W.A. Jr. pp 182-188 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

The ocean-bottom seismometer capsule contains a 1-hz vertical seismometer and triggerable or programmable digital recording system. The output of the seismometer is continuously digitized at 64, 128, or 256 samples/second. The digital data words are mixed with a time code and synchronization characters, serialized and passed through a 1536 sample shift register that acts as a delay line. The serial output bits are then encoded and recorded on a SONY TC800B tape recorder, which is turned on when a seismic event occurs. The event trigger occurs when the seismic signal jumps to eight times the time averaged input signal. A memory may be programmed to run the recorder on a schedule so that small amplitude signals from refraction shots are sure to be recorded. Data are recovered using the same recorder for playback and a decoder, which provides an analog output for field data interpretation or a digital output for computer analysis. The transponder also allows precise ranges between the capsule and ship to be determined. In addition, release or diagnostics may be commanded from the surface ship. The capsule itself falls freely to the ocean bottom. After a predetermined time or when a release command is received, it is released from a 150-lb steel tripod and floats to the surface. A dual timer and explosive bolt system is used to increase recovery reliability.

33294 Improving the odds in your offshore development program. Frye, D.W.; Crow, B.B. pp 197-200 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Most seismic data is used for structural purposes only, ignoring largely the reflection strength variations, reflection frequency and polarity. The coarseness of measurement and a suitable means of display have been limiting factors. An unusual, but accurate method of measuring geophysical variables is described. The most important conclusion is that geological changes too subtle to be observed by normal means may be displayed by the method described. The significance of the study is that the productive limits of fields have been established in a variety of exploration theatres and in rocks as old as the Jurassic period.

33295 Determination of the Earth heat flow at the surface (RTW method). Gordienko, V.V.; Zavgorodnyaya, O.V. (Inst. of Geophysics, Kiev). *Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz.;* No. 72, 84-92(1976). (In Russian).

A new method is suggested for determination of the Earth heat flow. It is based on long-term observations of temperature at small depths (to some meters). The method is tested in the territory of the Ukraine using the results of temperature measurements at meteorological stations at a depth of 0.2 and 3.2 m. The obtained heat flows are compared with those measured in the holes. Coincidence of the results is satisfactory.

33296 Determination of signal and noise amplitude spectra from their mixture in the common depth point seismogram. Karpenko, I.V. *Dopov. Akad. Nauk Ukr. RSR, Ser. B;* No. 7, 588-592(Jul 1976). (In Ukrainian).

A method is suggested to determine signal and noise amplitude spectra from their mixture in the CDP seismogram. The method is based on studies in the dependence between the amplitude spectra of CDP sum-trace and primary traces of CDP seismogram.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 33282

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 32067, 32898

33297 (COO—3236-9) **Nuclear chemistry and geochemistry research. Progress report, 1973—1976.** Kohman, T.P. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemistry). 20 May 1976. Contract EY-76-S-02-3236. 83p. Dep. NTIS $5.00.

Research is reported on: uranium—thorium—lead geochronology of terrestrial rocks, $^{147}Sm—^{143}Nd$ method of geochronology, tables of uranium—thorium—lead decay-growth functions, uranium—thorium—lead dating of meteorites, ^{92}Nb as a possible extinct natural radionuclide, chronology of galactic heavy-element nucleosynthesis, environmental lead, lead-isotope ratio as tracer of lead intake by children, lead-isotope ratios in works of art, and mass spectrometry and data reduction. (DLC)

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 31791

33298 **Sediment transport studies, nearshore Continental Shelf off Maryland.** Wilson, D.G.; Guala, J.R.; Palmer, H.D.; Blanton, J. pp 201-204 of In Eighth annual offshore technology conference. Vol. 1. Dallas; Offshore Technology Conference (1976).

From Offshore technology conference; Houston, Texas, United States of America (USA) (3 May 1976).

See CONF-760577—P1.

Instrumentation on the seafloor has yielded fair-weather data which support the contention that a seaward drift of bottom waters prevails off the central U.S. east coast. Vector average diagrams show a net offshore displacement of water of 8.3 km/day on the crest of the shoal, while the shoreward trough revealed only 0.8 km/day in the same direction. Currents capable of transporting indigenous sand exceeded the threshold velocity 58 percent of the time on the crest, but only 26 percent of the time in the trough between the shoal and shore. Information derived from this investigation will be essential to the prediction of wave-induced sediment transport associated with seasonal aspects of wave spectra derived from bottom-mounted wave gauges and current meters. Such studies will provide information on scour potential and erosion/deposition regimes bearing upon the design of nearshore facilities which occupy or pass through the shallow regions off the coast.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

33299 **Collisional pumping of a cosmic H_2O maser in a shock wave.** Shmeld, I.K.; Strel'nitskii, V.S.; Muzylev, V.V. (Radio Astrophysical Observatory, Latvian Academy of Sciences, Astronomical Council, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 411-418(Jul 1976).

The possibility of collisional pumping of a cosmic H_2O maser behind a circumstellar shock front is investigated. A homogeneous isothermal layer of finite optical thickness in the H_2O rotational lines is adopted as a model of the pump region. The equations of statistical equilibrium for the populations of 48—60 rotational levels of ortho-H_2O and the radiative-transfer equations for the 106—142 strongest transitions between these levels are solved simultaneously by computer. The cross section for collisional deexcitation of the molecules by neutral particles is assumed to be the same for transitions to any lower magnetic sublevel. Inversion of the $6_{16}—5_{23}$ transition (and of many other rotational transitions) will occur if the exciting particles have a density in the range 10^7approximately-less-thann/sub H/approximately-less-than10^{10} cm^{-3} for a kinetic temperature of 500—1000degreeK, and the optical thickness of the layer will impose hardly any restriction. Unlike de Jong, it is here concluded that inversion is mainly caused not by radiation trapping through multiple scattering of the rotational photons, but by cascade deexcitation of high rotational levels previously excited by collisions. A possible geometrical model for a strong H_2O maser source is discussed.

33300 **Have we seen a heavy antinucleus.** Hagstrom, R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **38**: No. 13, 729-732(28 Mar 1977).

The hypothesis of the first observed heavy antinucleus is proposed for the event of Price et al. This hypothesis demands depletion of the high-energy knock-on electrons, which should be clearly evident in the nuclear emulsion. This hypothesis does not directly contradict any previous antimatter search; and conflict with extrapolations from previous searches is of small statistical significance.

STARS

33301 (LA—6664) **Dynamical zoning within a Lagrangian mesh by use of DYN, a stellar pulsation code.** Castor, J.I.; Davis, C.G.; Davison, D.K. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 33p. Dep. NTIS $4.00.

A method of dynamical zoning within a Lagrangian mesh is used to resolve the motion of the hydrogen ionization front in a time-dependent nonlinear model of a pulsating star. The resulting coupling with the radiative-transfer improves the calculated light curves. The method is described is some detail and then applied to a model of the Cepheid eta Aq1. 8 figures, 1 table.

33302 **Detectability of Wolf—Rayet binaries from x rays.** Cherepashchuk, A.M. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 138-139(Jul 1976).

The existence of a companion to a WR star might be established from periodically variable x rays (L/sub x/approximately-less-than10^{34} erg/sec in the 1—10 keV energy range) emitted by the shock wave that would be generated when the WR envelope material interacts with the companion or its stellar wind.

33303 **On the theory of line formation in stellar spectra.** Sobolev, V.V. (Leningrad University). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 385-387(Jul 1976).

The problem of radiative transfer in a spectral line with complete frequency redistribution is considered. The ratio of the line scattering coefficient to the continuum opacity is assumed to depend on optical depth. An integral equation is derived from which line profiles (both absorption and emission) in a stellar spectrum can be determined.

33304 **Dynamical evolution of the subsystem of bright stars in the zeta Persei association.** Duboshin, G.N.; Dolgachev, V.P.; Kalinina, E.P.; Rybakov, A.I.; Kholopov, P.N. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 392-396(Jul 1976).

The possible dynamical evolution of the subsystem comprising the 17 brightest members of the zeta Persei association is investigated by numerical integration of a system of 102nd-order equations of motion. The subsystem is assumed to be part of a steady-state star cluster in the course of formation. In order for the subsystem itself to be stable, the cluster must have a total mass of (1.8—2.7) x 10^5 M/sub sun/. Apparently about 20—30% of the stars considered will leave the cluster at velocities in excess of the escape velocity.

33305 **Mass loss by stars in the gravitational-contraction phase.** Bisnovatyi-Kogan, G.S.; Lamzin, S.A. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 418-422(Jul 1976).

Self-consistent models of isentropic hydrogen stars experiencing steady outflow of mass are calculated. The properties of the models and their relationship to young contracting stars are investigated.

33306 **Origin of the peculiarities in the Crab Nebula.** Shklovskii, I.S. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 422-424(Jul 1976).

All the peculiarities observed in the Crab Nebula may be attributed to the anomalously low expansion velocity of its filaments. The Crab has a very small "evolutionary age"; it is the youngest object of its kind. The envelope of the 1054 supernova had an initial kinetic energy at least several tens of times smaller than in other remnants. Possible explanations are discussed in the general context of the nature of supernovae. In particular, it is suggested that type I presupernovae should be highly evolved objects such as white dwarfs.

33307 **Superdense stars in the quantum limit of ultrastrong frozen-in magnetic fields.** Shul'man, G.A. (Brest Teachers' College, Belorussian SSR). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 425-428(Jul 1976).

The physical conditions in the interior of a standard pulsar with an ultrastrong frozen-in magnetic field are examined. For a zero Landau energy level in the quantum limit of ultrastrong magnetic fields, the effects on the degree of degeneracy and on the perfect-gas approximation are estimated for electron and proton gases of superdense matter whose density is of the order of the nuclear density.

33308 **A radiating accretion column as a model for an x-ray pulsar.** Kaminker, A.D.; Fedorenko, V.N.; Tsygan, A.I. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 436-438(Jul 1976).

The process of plasma accretion onto a neutron star with a strong magnetic field is considered. It is assumed that a substantial part of the gravitational energy of the gas being accreted can be released as radiation in the accretion column at a distance of a few radii from the star. The theory is consistent with observations of the

x-ray pulsar. Her X-1, and predicts that the pulsar would have a supplementary source of soft γ rays at energies E150 keV.

33309 Thermal radio emission from an explosion in a stellar atmosphere. Uralov, A.M. (Siberian Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 438-440(Jul 1976).

The characteristic time behavior of the thermal radio bursts emanating from an abrupt release of energy in a stellar atmosphere is established.

33310 Thermal equilibrium in the presence of a magnetic flux tube in a stellar convection zone. Vandakurov, Y.V. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 446-449(Jul 1976).

The equilibrium of an axisymmetric flux tube with poloidal and toroidal magnetic fields in the upper layers of a convective stellar envelope is considered. For the case of a thin tube, the distortions of the equilibrium structure that are produced in adjoining nonmagnetized regions are determined. In particular, the convective heat flow will generally become asymmetric. One may speculate that an effect of this kind might play a useful role in compensating (on the average) for the flow asymmetry induced by the rotation of the medium. Some problems concerning convection on the sun are discussed briefly from this viewpoint.

33311 Stellar energy-loss rates due to S, P, or T neutral currents. Dicus, D.A.; Kolb, E.W. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). *Phys. Rev., D;* **15**: No. 4, 977-982(15 Feb 1977).

The energy-loss rate in stellar matter due to neutrino production is calculated assuming that the weak leptonic neutral current includes scalar, pseudoscalar, or tensor covariants. The processes $e^+ + e^-$ yields ν + nu-bar, γ + e yields + ν + nu-bar, e + Z yields e + Z + ν + nu-bar, and $\gamma + \gamma$ yields ν + nu-bar are considered in the respective temperature and density regions of physical significance. Comparison with observed stellar lifetimes allows an upper limit to be placed on the new couplings.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

REFER ALSO TO CITATION(S) 33299

33312 Is Cygnus X-3 a pulsar with a period of 4.8 hours. Syunyaev, R.A. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 129-130(Jul 1976).

The Cygnus X-3 source might represent a long-period accreting pulsar, a companion to a red supergiant in a binary system with an orbital period of several years.

33313 Possible evolution of a binary-system radio pulsar as an old object with a weak magnetic field. Bisnovatyi-Kogan, G.S.; Komberg, B.V. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 130-132(Jul 1976).

Arguments are given indicating that a radio pulsar in a close binary system can first pass through an x-ray pulsar phase, accompanied by a drop in its magnetic-field strength and an acceleration of its rotation.

33314 On the nature of binary-system x-ray pulsars. Lipunov, V.M.; Shakura, N.I. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 133-135(Jul 1976).

A model rotating neutron star in the accretion phase provides a natural explanation for both long- and short-period x-ray pulsars in binary systems. Two alternative models are proposed for long-period pulsars; the choice depends on the prior history of the stellar wind flowing from the optical companion. The opportunities for an observational test of the models are discussed. A trigger mechanism for turning on an intermittent x-ray pulsar in a model binary system is suggested.

33315 On the physical nature of x-ray novae. Amnuel', P.R.; Guseinov, O.K. (Shemakha Astrophysical Observatory, Azerbaidzhan Academy of Sciences). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 152-154(Jul 1976).

An interpretation is offered for observational data on transient x-ray sources such as A0620-00 and A1524: 62. X-ray flares would occur in binary systems containing a relativistic star that is accreting stellar wind. In a steady state such systems would appear as weak x-ray sources.

33316 On the relationship between the infrared source CRL 2591 (UOA-27) and its radio and H_2O counterparts. Wynn-Williams, C.G.; Becklin, E.E.; Forster, J.R.; Matthews, K.; Neugebauer, G.; Welch, W.J.; Wright, M.C.H. (California Institute of Technology). *Astrophys. J., Lett.;* **211**: No. 2, L89-L90(15 Jan 1977).

New radio, infrared, and H_2O maser observations show that there is a 7′ angular separation between the protostar-like infrared source CRL 2591 and the compact H II region which has until now been identified with it, while the H_2O maser coincides with the infrared source. This result, together with an extension of photometric measurements to 20 μm and a much improved upper limit to its angular size, reinforces the apparent similarity of CRL 2591 to the BN object in Orion and to W3/IRS 5.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 33337

33317 (PB—247 137-380-1/SL) Solar—geophysical data number 380. Part I. (Prompt reports). Data for March 1976-February 1976. Explanation of data reports issued as number 378 (supplement) February 1976. Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Apr 1976. 126p. (SGD—380-Pt-1). Paper copy available from National Climatic Center, Attn: Publications, Federal Bldg., Asheville, N.C. 28801. Subscription $34.00/year includes Part 1 (Prompt Reports) and Part 2 (Comprehensive Reports); $18.00/year for either part. Annual supplement containing explanation is included. $1.50/copy for either part; $1.40 for the extra issue.

See also PB-247 137-380-2 and PB-247 137-379-1.

This report includes imageries that measure solar brightness. The D2-B satellite launched from French Guiana on September 27, 1975, has been collecting spectroheliograms in the wavelength range 170-1300A since October 15, 1975. Spectroheliograms at the wavelength of the 284 A Fe XV line are received on a daily basis. (GRA)

33318 (PB—247 137-380-2/SL) Solar—geophysical data number 380. Part II. (Comprehensive reports). Data for October 1975—September 1975 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976. Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Apr 1976. 34p. (SGD—380-Pt-2). Paper copy available from National Climatic Center, Attn: Publications, Federal Bldg., Asheville, N.C. 28801. Subscription $34.00/year includes Part 1 (Prompt Reports) and Part 2 (Comprehensive Reports); $18.00/year for either part. Annual supplement containing explanation is included. $1.50/copy for either part; $1.40 for the extra issue.

See also PB-247 137-380-1 and PB-247-137-379-2.

This is part two of Solar—Geophysical Data No. 380. Included are data that give measurements of solar activity for the months October and September 1975. These data reports are based on results from the D2-B satellite, which was launched from French Guiana and which has been collecting spectroheliograms. (GRA)

33319 (PB—247 137-381-1/SL) Solar—geophysical data number 381. Part I. (Prompt reports). Data for April 1976—March 1976. Explanation of data reports issued as number 378 (supplement) February 1976. Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). May 1976. 131p. (SGD—381-Pt-1). Paper copy available from National Climatic Center, Attn: Publications, Federal Bldg., Asheville, N.C. 28801. Subscription $34.00/year includes Part 1 (Prompt Reports) and Part 2 (Comprehensive Reports); $18.00/year for either part. Annual supplement containing explanation is included. $1.50/copy for either part; $1.40 for the extra issue.

See also PB-247 137-380-1 and PB-247 137-381-2.

This report includes charts and imageries of solar activity recorded for the months of March and April of 1976. April data include daily solar activity centers, sudden ionospheric disturbances, solar radio waves, cosmic rays, geomagnetic indices, and radio propagation indices. (GRA)

33320 (PB—247 137-381-2/SL) Solar—geophysical data number 381. Part II. (Comprehensive reports). Data for November 1975-October 1975 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976. Leighton, H.I. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). May 1976. 52p. (SGD—381-Pt-2). Paper copy available from National Climatic Center, Attn: Publications, Federal Bldg., Asheville, N.C. 28801. Subscription $34.00/year includes Part 1 (Prompt Reports) and Part 2 (Comprehensive Reports); $18.00/year for either part. Annual supplement containing explanation is included. $1.50/copy for either part; $1.40 for the extra issue.

See also PB-247 137-380-2 and PB-247 137-381-1.

This is part two (comprehensive reports) of a two part report on Solar—Geophysical Data. Included in this report are data for the months of October and November. The data recorded include solar flares, solar radio waves, energetic solar particles and plasma, and magnetograms of geomagnetic storms. (GRA)

33321 (PB—261462) Solar—geophysical data number 385. Part II. (Comprehensive reports). Data for March 1976—February 1976 and miscellanea. Explanation of data reports issued as number 378 (supplement) February 1976. Leighton, H.I. (National Geophysical

and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Sep 1976. 66p. (SGD—385-Pt-2). Paper copy available from National Climatic Center, Attn: Publications. Federal Bldg., Asheville, N.C. 28801. Subscription $34.00/year includes Part 1 (Prompt Reports) and Part 2 (Comprehensive Reports); $18.00/year for either part. Annual supplement containing explanation is included. $1.50/copy for either part; $1.40 for the extra issue.

See also PB—247137-384-2 and PB—261461.

This comprehensive report for March 1976, and February 1976 and Miscellanea provides data on solar flares, solar radio waves, energetic solar particles and plasma, abbreviated calendar record, regional flare index, spectral and radioheliograph events--Culgoora, June 1976, and geomagnetic indices--June 1976. (GRA)

33322 Correlation between quasiperiodic fluctuations of period longer than 30 min in 3-cm solar radio emission and the development of proton flares. Kobrin, M.M.; Korshunov, A.I.; Arbuzov, S.I.; Pakhomov, V.V.; Fridman, V.M. (Gor'kii Radiophysics Institute). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 444-446(Jul 1976).

The correlation is investigated of fluctuations in the slope of the spectrum and in the intensity of the centimeter radio emission of the sun with solar activity. Quasiperiodic pulsations in the slope of the radio spectrum with periods longer than 30 min are closely correlated with proton events. Their amplitude rises noticeably several days prior to a proton flare, and immediately afterward it decays sharply. This behavior has been observed before all proton events within the interval of observation, and in no other cases. The amplitude of pulsations with characteristic times shorter than 20 min increases with the general level of solar activity, but no correlation with individual flares on the sun has been found.

33323 Microstructure in the continuous radiation of type IV meter bursts. Observations and model of the source. Chernov, G.P. (Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 449-459(Jul 1976).

The results of high-resolution spectral observations for July 3, 1974, during which a unique microstructure of the continuous radiation of a type IV meter burst was recorded on the spectrographs of the Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, USSR Academy of Sciences, are discussed. The continuum radiation was modulated by one-second pulsations consisting of bands and points in emission and absorption which produced complex chaotic forms in the spectrum. Various radiation microstructures observed in other events are compared and the principal demands on the generation mechanism are worked out. A model is proposed for the radiation source in the form of a magnetic field tube in which the high-frequency emission can be modulated by wave packets of whistlers. The interaction of whistlers with Langmuir oscillations is discussed in detail in the second part of the report.

33324 Local sources of solar radio radiation based on observations at Pulkovo in March 1970. Akhmedov, S.B.; Borovik, V.N.; Ikhsanova, V.N.; Nagnibeda, V.G.; Peterova, N.G. (Main Astronomical Observatory, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 460-465(Jul 1976).

Results are presented on spectral polarization observations (in the 2—9 cm range) of the sun with high resolution (0.7—3.0 ang. min) on the Large Pulkovo Radio Telescope in the period from February 28 to March 15, 1970. Dynamic spectra are obtained for two local sources (l.s.) of the S-component of the solar radio radiation in unpolarized radiation. It is found that the character of the spectrum changes during the course of development of the l.s. and that these changes, which mainly appear in the long-wave part of the spectrum (6—9 cm), are connected with changes in the structure of the sunspot qroups corresponding to this l.s. It was found that the spectrum of the polarized radiation of the l.s. under consideration has a well-expressed maximum near $\lambda=3$ cm. It is established that the dimensions of the sources of unpolarized radiation depend on the wavelength, monotonically increasing threefold in the range from 2 to 9 cm. The results of the observations are interpreted starting from the hypothesis that the l.s. emission has a thermal nature. Assuming that the l.s. emission is due to the combined action of bremmstrahlung and gyroresonance emission mechanisms, and assigning a model of the magnetic field of the sunspots, a distribution T/sub e/(h) of the electron temperature with height is obtained on the basis of the results of observations for one l.s.

33325 Calculation of helium population levels in a flare. Mitropol'skaya, O.N. (P. K. Shternberg State Astronomical Institute). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 471-473(Jul 1976).

Steady-state equations for the populations of helium levels 1^1S, 2^3S, and 2^3P are constructed for a solar flare. Their solution using the flare model proposed by S. B. Pikel'ner and N. D. Kostyuk {Astron. Zh. 51, 1002 (1974) [Sov. Astron. 18, 590 (1975)]} made it possible to determine the optical depths of the helium D_3 and λ10,830 A lines in the flare as well as the numbers of helium atoms in the 2^3S and 2^3P states in a flare column above 1 cm^2. The values obtained agree in order of magnitude with those derived from observations of D_3 line profiles in flares by various authors.

33326 Effect on the curve of growth of the parity of NiI spectral terms. Kuli-Zade, D.M. (S. M. Kirov Azerbaidzhan State University). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 473-475(Jul 1976).

The excitation temperature of the sun's photosphere is determined from the lines of even-odd and odd-even NiI transitions. It is found that the excitation temperature determined from the lines of odd-even transitions is somewhat higher than that determined from the lines of even-odd transitions. The mean excitation temperatures for even-odd and odd-even transitions are T/sub e/(TyieldsT/sup o/) =4850degreeK and T/sub e/(T/sup o/yieldsT) =5600degreeK, respectively. The mean exciation temperature determined from the lines of both transitions proved to be T/sub e/(TyieldsT/sup o/, T/sup o/yieldsT) =5100degreeK. Then a curve of growth is constructed for the center of the sun's disk from 229 NiI lines for the Milne-Eddington approximation for three cases: 1) from lines of even-odd transitions; 2) from lines of odd-even transitions; 3) from lines of both transitions. It is shown that in contrast to the case of FeI no clearly expressed difference between the curves of growth for lines of even-odd and odd-even NiI transitions is observed. This is connected with the fact that the lines of these transitions are concentrated in different sections of the curve of growth.

33327 Solar wind heat flux regulation by the whistler instability. Gary, S.P.; Feldman, W.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **82**: No. 7, 1087-1094(1 Mar 1977).

This paper studies the role of the whistler instability in the regulation of the solar wind heat flux near 1 AU. A comparison of linear and second-order theory with experimental results provides strong evidence that the whistler may at times contribute to the limitation of this heat flux.

GALAXIES

33328 "Cavities" in the intergalactic medium. Ozernoi, L.M.; Chernomordik, V.V. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 145-147(Jul 1976).

Radiative energy losses by shock waves generated in young galaxies and by the activity of galaxy nuclei and quasars may tend to produce hot rarefied "cavities" in the intergalactic medium, surrounded by dense, cool "walls." As shock fronts emanating from various activity centers move across, the intergalactic gas will develop an inhomogeneous "cavern"-type structure composed of interconnected cavities. If structure of this kind were discovered, information might be gained on the density of the undisturbed intergalactic gas.

33329 Metallicity function of globular clusters: evidence for three active phases in the evolution of the Galaxy. Marsakov, V.A.; Suchkov, A.A. (Scientific Research Institute of Physics, Rostov University). *Sov. Astron. Lett. (Engl. Transl.);* **2**: No. 4, 148-150(Jul 1976).

The metallicity function for the globular clusters in the Galaxy is represented by a triple-humped curve, suggesting that three peaks in the metal enrichment of the Galaxy occurred during the period of cluster formation. Some constraints on the nature of the metal sources and on the early evolution of the Galaxy are discussed.

33330 The subsystem of globular clusters in the Galaxy. Sharov, A.S. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 397-402(Jul 1976).

The structure of the subsystem of globular clusters in the Galaxy is considered, with special attention to selection effects preventing the recognition of distant objects. Clusters of spectral type G (objects with a high heavy-element abundance) are shown to form a disk with semiaxes of about 8 and 2 kpc. Some F-type clusters (metal-deficient objects) also comprise a disk, perhaps of somewhat larger size; the remainder form an extended halo of low density. The logarithmic space-density gradients in the planes of the F- and G-cluster disks and for all the clusters combined are found to be 0.1, a value appreciably smaller than that previously accepted for the globular-cluster subsystem. The total number of clusters in the Galaxy is estimated to be about 500, with nearly the same representation of F and G clusters. The G disk clusters and possibly the F disk clusters have a smaller radial-velocity dispersion than the halo objects. These results are consistent with the idea that globular clusters were produced through contraction and subsequent evolution of the protogalactic gas cloud, and they suggest that the formative process may have entailed two or three steps.

33331 Deuterium formation by nonequilibrium processes. Gol'dberg, V.Z.; Chechetkin, V.M. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 440-444(Jul 1976).

The mechanism of deuterium formation in nonequilibrium processes through spallation of He^4 nuclei by high-energy protons is

discussed. In this case as well, much lithium will be produced by the α (α, Li^7) p and α (α, Li^6)D reactions. The D/Li abundance ratio for these processes is found to be two orders of magnitude lower than the observed cosmic abundance.

COSMOLOGY

REFER ALSO TO CITATION(S) 33297, 33355

33332 (AD—A032271) **Noise measurements of the lowest frequency longitudinal mode of an aluminum cylinder at liquid nitrogen temperatures. Annual report 1 Nov 75—31 Dec 76.** Davis, W.S.; Gretz, D.; Richard, J.P.; Rydbeck, G.; Weber, J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Aug 1976. Contract N00014-76-C-0428. 26p. Q 03/MF/A01.

The lowest frequency longitudinal mode of an aluminum cylinder has been studied over the temperature range 60 K — 78 K. Lead zirconate titanate crystals were bonded to the cylinder for observation of the thermal fluctuations and relaxation phenomena. Large amounts of excess noise were observed whenever the cylinder was not in thermal equilibrium. The cylinder appeared to have attained thermal equilibrium after its temperature had been maintained near liquid nitrogen temperatures for several weeks. Noise temperatures within a factor 2 of the temperature measured by a platinum resistance thermometer were observed when the mean temperature of the cylinder was drifting less than 0.01 Kelvin per day. The very large fluctuations in noise temperature are not understood and warrant further investigation. (auth)

PLANETARY PHENOMENA

33333 **Plane vortices with elliptical nuclei on Jupiter (Great Red Spot) and on the earth.** Shuleikin, V.V. (Black Sea Branch of Marine Hydrophysical Institute, Academy of Sciences of the Ukranian SSR). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 481-486(Jul 1976).

According to the generally recognized hypothesis of G.S. Golitsyn, the Great Red Spot (GRS) on Jupiter consists of a gigantic vortex. Only the conditions of formation of an elliptical rather than a circular form of the nucleus of this vortex have remained unknown. At one time the author of the present article showed that on the earth, in the zone of the Atlantic Ocean between 10°N and 40°N, the water currents can be approximated as traveling along ellipses with a common western focus. In going around it the streamlines are bunched in toward the west and spread out toward the east, as a consequence of the so-called β-effect produced by the decrease in the Coriolis parameter f as the equator is approached. Here, this system of cyclic currents is adopted as the model for the GRS. There is a basis for assuming that the GRS, lying between two oppositely directed zonal streams, arose and is maintained through hydrodynamic actions on their part, similar to those experienced by the system of cyclic currents in the Atlantic on the part of the corresponding zonal streams in the atmosphere.

33334 **Transfer of angular momentum in the protoplanetary cloud by meridional currents.** Ruzmaikina, T.V.; Safronov, V.S. (Institute of Earth Physics, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 4, 486-489(Jul 1976).

It is shown that the axisymmetric motions produced by meridional circulation and the Goldreich-Schubert instability cannot provide the required transfer of angular momentum in a nonturbulized protoplanetary cloud. More efficient momentum transfer can be expected in a cloud with developed turbulence or convection, taking into account the possibility of the generation of a large-scale magnetic field or large-scale motions.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 33317, 33319

33335 (AD—A029324) **On seeding the D-region with cesium. Technical note.** Chamberlain, J.W. (Stanford Research Inst., Menlo Park, Calif. (USA)). Jun 1976. Contract DAHC15-73-C-0370,. 15p. (SRI-JSR—74-5). NTIS (US Sales Only) $3.50.

If 1000 kg (7500 moles) of cesium were deposited over a 10-km height interval centered about 80-km altitude, the cloud would spread within 1/4 hour to a 50-km radius, leaving a mean density of (Cs) = 6 x 10^7 cm^{-3}. Chemical reactions with oxygen would consume about 25% of the cesium, but most of it would remain in atomic form. Solar ionization is very effective, and Cs^+ will not transfer its charge to atmospheric constituents, there results nearly 100% ionization of the free Cs and free-electron densities of nearly 3 x 10^7 cm^{-3} in less than an hour after a daytime release. Although the ionization will decrease rapidly at night, it will reappear again at sunrise, with electron densities of the order of 100,000 cm^{-3} persisting for days. Disturbed radio propagation in vhf, and especially hf, would be present for days, possibly over distances up to several thousand kilometers. Seeding the D region with substantial quantities of cesium would provide a valuable diagnostic tool for investigation of the local atmospheric dynamics, but it could also produce undesirable effects on normal radio communications. (GRA)

33336 (AD—A030223) **A nonlinear model for equatorial spread F: irregularity and scintillation calculations. Memorandum report.** McDonald, B.E.; Ossakow, S.L.; Scannapieco, A.J. (Naval Research Lab., Washington, D.C. (USA)). Aug 1976. 11p. (NRL-MR—3348). NTIS (US Sales Only) $3.50.

It is shown that a simple nonlinear model based upon plasma equations of motion and a wave equation for radio propagation is capable of predicting plasma irregularities and scintillations at the equator. The irregularities develop from a linear convective instability on the bottom of the F layer. Depleted regions, or bubbles, form and rise nonlinearly through the F peak, disturbing the top of the F layer. The equations of motion are integrated numerically, and then the parabolic equation is solved for propagation of a 300 MHz wave through the plasma. A modest total electron content of 5 x 10 to the 16th Power M(-2) is assumed. From the radio wave solution scintillation indices are extracted as a function of time. Approximately two hours after the instability starts, S4 reaches 0.48, and the log power variance reaches 3.1 dB. (GRA)

33337 (AD—A030301) **Predicting riometer absorption for solar radio bursts. I. Correlations between proton spectra and riometer absorption.** Bakshi, P.; Barron, W. (Boston Coll., Chestnut Hill, Mass. (USA). Dept. of Physics). Jun 1976. Contract F19628-76-C-0008. 27p. NTIS (US Sales Only) $4.00.

Observed riometer absorption A (in db) is correlated with the proton spectrum variable (log I (<10 MeV) + alpha log Rho), where I(<10 MeV) is the peak flux of protons with energies in excess of 10 MeV, Rho is a measure of the average energy of these protons and alpha is an adjustable parameter. Study of the major proton events (I(<10 MeV) < 100 protons/cm^2—s—ster) since 1967 shows excellent correlations. Even when the average energy dependent factor is ignored (alpha=0), this approach provides better correlations than the usual square root relation; optimization over alpha further improves the correlations to r nearly equivalent to 0.97. A practical program for utilizing solar radio burst data for an early prediction of riometer absorption can now be developed by combining previous studies on radio results from proton correlations with the proton results from riometer results reported here. (GRA)

33338 (PB—255875) **Analysis of occurrence of sporadic E and accuracy of predictions of sporadic-E critical frequencies for temperate latitude northern hemisphere stations.** Gosnell, P.; Leftin, M. (Office of Telecommunications, Boulder, Colo. (USA). Inst. for Telecommunication Sciences). Jun 1976. 42p. (OTR—76-89). NTIS (US Sales Only) $4.00.

Sponsored in part by Office of the Director of Defense Research and Engineering, Washington, D.C.

A study was conducted to determine the percentage of time that sporadic E was observed at fifteen locations during four years (1965, 1967, 1969, and 1971), and the accuracy of sporadic-E predictions based on the ITS numerical coefficients. Results indicate that sporadic E is present almost 50% of the time during summer at mid-latitudes and at night in the high latitudes, and updated coefficients may well predict the general trend of observations more closely than the current coefficients. (GRA)

33339 (PB—255904) **World maps of sporadic E (foEs greater than 7 MHZ) for use in prediction of vhf oblique-incidence propagation. Special publ.** Smith, E.K. (Office of Telecommunications, Boulder, Colo. (USA). Inst. for Telecommunication Sciences). Jun 1976. 66p. (OT-SP—76-10). NTIS (US Sales Only) $4.50.

The report presents three world-wide maps of sporadic E (foEs <7 MHz) derived from published vertical-incidence maps supplemented by new ionosonde data. (GRA)

MAGNETOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 33317, 33319, 33320, 33321

33340 (PB—261463) **ATS6 radio beacon electron content measurements at Boulder, July 1974—May 1975.** Fritz, R.B. (World Data Center A for Solar-Terrestrial Physics, Boulder, Colo. (USA)). Sep 1976. 68p. (UAG—58). Paper copy available from National Climatic Center, Federal Bldg., Asheville, N.C. 28801, Attn: Publications.

Routine monitoring of the plasmaspheric content was a primary objective of the ATS6 Radio Beacon Experiment (RBE) and this set critical requirements on transmitter and receiver stabilities. The satellite transmitted linearly polarized signals on carrier frequencies of 40.016, 140.056, and 360.144 MHz, with modulations of 100.04 kHz and 1.004 MHz. This provided coarse and fine scales of measurements so that the cycle ambiguity in the phase measurements of both Faraday rotation and group delay could be resolved. This

report summarizes 140 MHz data recorded at the Boulder, Colorado, ground station (40.13 degrees N, 105.24 degrees W) while ATS6 was positioned above 94 degrees west longitude, between July 1974 and May 1975. The satellite appeared at an azimuth of 163 degrees, elevation 42 degrees, with the projection of the ray path near the ground. All data were digitally recorded once per second. (GRA)

33341 Contribution to the theory of trigger radiation. Shapiro, V.D.; Shevchenko, V.I. (Institute of Space Research, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **23**: No. 12, 619-622(20 Jun 1976).

A theory is constructed for the generation of monochromatic radiation when the magnetosphere is probed by whistlers of sufficiently large amplitude. The investigated generation mechanism is based on velocity bunching of the resonant particles in the field of the main wave. Radiation with time-varying frequency is produced when the resultant bunches move in the geomagnetic field.

33342 Role of longitudinal magnetic-field inhomogeneity in cyclotron instability of the plasmasphere. Kaladze, T.D.; Mikhailovskii, A.B.; Potapov, A.S.; Pokhotelov, O.A. (O. Yu. Schmidt Institute of Geophysics, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 370-373(Jul 1976).

A theory is worked out for the cyclotron instability of the plasmasphere with a longitudinal inhomogeneity of the magnetic field taken into account. In this case, the instability converts from a hydrodynamic instability into a kinetic instability. The influence of bounce effects on the evolution of the instability is analyzed; the result is an increase in the growth rate. The theoretical results are used to interpret the mechanism for the generation of cyclotron waves in the magnetosphere.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

33343 A search for the infrared fundamental of matrix-isolated XeF . Ault, B.S.; Andrews, L.; Green, D.W.; Reedy, G.T. (Chemistry Department, University of Virginia, Charlottesville, Virginia 22901). *J. Chem. Phys.;* **66**: No. 7, 2786-2788(1 Apr 1977).

Various xenon/fluorine mixtures were photolyzed in solid argon matrices and examined in the infrared spectral region with either a Fourier transform spectrometer or with a grating spectrometer. After photolysis, a strong peak was observed at 215 cm^{-1} in addition to the known $XeF_2(\nu_3)$ peak at 549 cm^{-1}. The appearance of the same two bands in Ar matrices containing the vapors over XeF_2 indicated the assignment of the 215 cm^{-1} band to $XeF_2(\nu_3)$. The fundamental of XeF was not observed either because it is masked by the $XeF_2(\nu_2)$ peak or because it has a small infrared absorption coefficient.

33344 Surface structures of normal paraffins and cyclohexane monolayers and thin crystals grown on the (111) crystal face of platinum. A low-energy electron diffraction study. Firment, L.E.; Somorjai, G.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **66**: No. 7, 2901-2913(1 Apr 1977).

The surfaces of the normal paraffins (C_3—C_8) and cyclohexane have been studied using low-energy electron diffraction (LEED). The samples were prepared by vapor deposition on the (111) face of a platinum single crystal in ultrahigh vacuum, and were studied both as thick films and as adsorbed monolayers. These molecules form ordered monolayers on the clean metal surface in the temperature range 100—220 K and at a vapor flux corresponding to 10^{-7} Torr. In the adsorbed monolayers of the normal paraffins (C_4—C_8), the molecules lie with their chain axes parallel to the Pt surface and Pt[110]. The paraffin monolayer structures undergo order—disorder transitions as a function of temperature. Multilayers condensed upon the ordered monolayers maintained the same orientation and packing as found in the monolayers. The surface structures of the growing organic crystals do not corresond to planes in their reported bulk crystal structures and are evidence for epitaxial growth of pseudomorphic crystal forms. Multilayers of n-octane and n-heptane condensed upon disordered monolayers have also grown with the (001) plane of the triclinic bulk crystal structures parallel to the surface. n-Butane has three monolayer structures on Pt(111) and one of the three is maintained during growth of the crystal. Cyclohexane forms an ordered monolayer, upon which a multilayer of cyclohexane grows exhibiting the (001) surface orientation of the monoclinic bulk crystal structure. Surface structures of saturated hydrocarbons are found to be very susceptible to electron beam induced damage. Surface charging interferes with LEED only at sample thicknesses greater than 200 A.

BEAMS AND THEIR REACTIONS

33345 States of ions penetrating solids. Datz, S. (Oak Ridge National Lab., Tenn. (USA)). pp 119-167 of In Radiation damage processes in materials. Dupuy, C.H.S. (Lyon-1 Univ., 69 (France)). Leiden, The Netherlands; Noordhoff International (1975).

From NATO Advanced Study Institute on radiation damage processes in materials; Corsica, France (27 Aug 1973).

Energetic ions penetrating matter undergo a series of collisions in which electrons are captured or lost by the ion and in which excitation and ionization of both the ion and the atoms of the medium occur. These events are responsible for the slowing of the ion (electronic stopping) and for the generation of free electrons and radiation by the penetrating particle. In this paper the author discusses what is known about the mechanisms for these processes from studies of isolated atomic collisions and combines this knowledge with experimental data from collisions in solids to estimate ionic states in condensed media (both in random solids and in crystal channels).

33346 Multiple small-angle scattering of particles in a medium with an inverse-square potential. Mashkova, E.S.; Molchanov, V.A.; Snisar, V.A.; Firsov, O.B. (Scientific-Research Institute of Nuclear Physics, Moscow State University). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 316-321(Jul 1976).

An approximate equation is derived for the angle-energy distributions of light particles interaction with atoms in a medium according to an inverse-square potential, with an arbitrary stopping law. In a test of these conclusions, experiments were carried out on the scattering of 30-keV helium ions by a polycrystalline silver target.

33347 Chemical sputtering of graphite by H^+ ions. Busharov, N.P.; Gorbatov, E.A.; Gusev, V.M.; Guseva, M.I.; Martynenko, Y.V. (I. V. Kurchatove Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 321-323(Jul 1976).

In a study of the sputtering coefficient S for the sputtering of graphite by 10-keV H^+ ions as a function of the graphite temperature during the bombardment, it is found that at T< or =750degreeC the coefficient S is independent of the target temperature and has an anomalously high value, S=0.085 atom/ion. The high rate of sputtering of graphite by atomic hydrogen ions is shown to be due to chemical sputtering of the graphite, resulting primarily in the formation of CH_4 molecules. At T=1100degreeC, S falls off by a factor of about 3. A model for the chemical sputtering of graphite is proposed.

33348 Adaptation of an ion microprobe for ion bombardment of liquid metals. Fischer, A.K.; Steidl, D.V.; Johnson, C.E. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **48**: No. 3, 219-220(Mar 1977).

A technique involving a new substage assembly was developed to permit an ion microprobe mass analyzer (IMMA) to be used as an ion bombardment facility for molten metals (lithium) without harm to the instrument from the hot, reactive samples.

33349 Parametric focusing of intense ion beams. Mahaffey, R.A.; Marsh, S.J.; Golden, J.; Kapetanakos, C.A. (Naval Research Laboratory, Washington, D. C. 20375). *Appl. Phys. Lett.;* **30**: No. 9, 449-451(1 May 1977).

Focusing of charge- and current-neutralized intense ion beams is accomplished by propagating the beam along a spatially periodic axial magnetic field. This focusing results in local variations in the beam radius and density. At one location, the measured particle density is enhanced over the emitted density by at least a factor of 4. Current density enhancements in excess of an order of magnitude using this method should be obtainable.

ATOMIC AND MOLECULAR PROPERTIES

33350 (EUR-CEA-FC—827) Theoretical energy levels and wavelengths for some spectra of highly ionized molybdenum between Mo XL and Mo XXIV. Klapisch, M.; Perel, R.; Weil, D. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jun 1976. 49p. NTIS (US Sales Only).

Some lines of Mo XXXI and Mo XXXII were recently detected in the EUV Spectrum of Tokamak machines. In order to enable the identification of other lines in the soft X-rays to EUV range, systematic computations of energy levels and wavelengths were performed. 375 energy levels belonging to Mo XL, Mo XXXIII, Mo XXXII, Mo XXXI, Mo XXX and Mo XXIV were computed. The computations were performed with the relativistic parametric potential method, including configuration interactions. The results show the importance of both relativistic effects and configuration interactions for the few cases where some measurements exist, the agreement is excellent.

33351 Molecular orbital correlation diagrams for He_2, He_2^+, N_2, N_2^+, CO, and CO^+ . Ermler, W.C.; Mulliken, R.S.; Wahl, A.C. (Department of Chemistry, The University of Chicago, Chicago, Illinois 60637). *J. Chem. Phys.;* **66**: No. 7, 3031-3038(1 Apr 1977).

After a preliminary check with He_2 and He_2^+, self-consistent field calculations have been carried out for the nitrogen and carbon monoxide molecules and some of their positive ions for the range of internuclear distances from about 1.5 times equilibrium down to 0.01 bohr. To adequately describe the passage from the separated to the united atom limits, basis sets comprised of even-tempered expansions of Slater type s and p functions were centered at each nucleus and at a point midway between them. This three center procedure is compared with that of reoptimizing basis functions at each internuclear distance. It is found that the three-center approach almost completely obviates the need of the polarization functions which must be added if a two-center approach is used. The correlation diagrams for nitrogen and carbon monoxide and the first positive ions of each symmetry type are all similar in shape, especially for the innermost orbitals. Ionization potential curves plotted on the diagrams for the neutral systems are nearly parallel to the corresponding orbital energy curves. This indicates that Koopmans' theorem is consistent at all distances and implies that correlation diagrams for neutral molecules should be reasonable approximations to the ionization potential curves. For the most easily ionized orbital of both N_2 and especially CO, the ionization potential has a remarkably low value at about one-third the equilibrium separation. To adequately describe this orbital an extra s function having a smaller zeta than the smallest one in the united atom basis set was required. This implies that merely using the optimized basis sets for the separated and united atoms in a three-center procedure is scarcely acceptable in the region where the outermost orbital energy has the lowest value.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

33352 Experiments on hadronic-atom x-ray intensities of hydrides and deuterides. Wiegand, C.E.; Lum, G.K.; Godfrey, G.L. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., A;* **15**: No. 4, 1780-1781(Apr 1977).

Kaonic-atom x-ray intensities of elements Z = 3, 6, 8, 11, and 20 were significantly reduced when the elements were in hydride form. The ratios I (ZH/sub m/)/I (Z) have a noticeable Z dependence. Deuterides of C and O showed slightly less x-ray emission than their hydride counterparts.

COLLISION PHENOMENA

33353 (AD—A029458) **Determination of the binding energy of excited rare gas dimers. Final report 1 Jun 74—30 Jun 76.** Gillen, K.T. (Stanford Research Inst., Menlo Park, Calif. (USA)). 23 Aug 1976. Contract N00014-74-C-0307. 40p. (SRI-MP—76-79). NTIS (US Sales Only) $4.00.

Elastic scattering angular distributions have been measured for scattering of beams of metastable Ar^*, Ne^*, and Xe^* by their respective ground state atoms at collision energies in the eV range. For neon and argon, calculations have been performed to obtain improved estimates of the relevant interatomic potentials. For the lowest Ar_2^* excimer potential, 1(u), 0(u) - (3 Sigma u), the best available molecular beam and spectroscopic emission data are consistent with the following parameters in Morse-shape potential: D(e) = 0.78 +- 0.04 eV; R(e) = 2.33 +- 0.02 A; omega(e) = 322 +- 20/cm. (GRA)

33354 (AD—A029527) **Role of electron spin in the NF kinetic system. Interim report.** Herbelin, J.M. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 30 Jul 1976. Contract F04701-75-C-0076. 13p. (TR—0076(6240-40)-8). NTIS (US Sales Only) $3.50.

The reactions for the production and removal of the three lowest electronic states of nitrogen fluoride, NF(X triplet sigma), NF(a singlet delta), and NF(b singlet sigma +), are discussed from the standpoint of electron spin conservation. By invoking the Wigner—Witmer spin rule together with other spin-related properties, it is indicated that the electronically excited NF(a singlet delta) not only is the preferred product from the reaction of H, (D), and CH_3 with NF_2, but should also be less reactive toward other atoms, radicals, and itself than its ground-state counterpart NF(X triplet sigma). These conclusions are shown to be consistent with existing experimental results. (auth)

33355 Thermodynamic model for composite-particle emission in relativistic heavy-ion collisions. Mekjian, A. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev. Lett.;* **38**: No. 12, 640-643(21 Mar 1977).

A thermodynamic model, constructed in the framework of the big-bang equilibrium model, is proposed and used to study the spectra of high-energy composite particles that can be seen in relativistic heavy-ion collisions. Properties of the spectra are related to properties of the thermodynamic equilibrium region.

33356 Effect of resonances on the near-threshold electron detachment cross sections of F^-. Ormonde, S. (Quantum Systems, Inc., Albuquerque, New Mexico 87108). *Phys. Rev. Lett.;* **38**: No. 13, 690-693(28 Mar 1977).

Very narrow (~2 meV) ^1D and ^1P shape resonances above the ground state of atomic fluorine lead to electron and photon near-threshold F^- detachment cross sections of approximately (2—3) x 10^{-15} and 4 x 10^{-14} cm^2, respectively, and could affect the F-atom production rates in the relativistic-electron-beam H_2/F_2 lasers.

33357 Electron-impact excitation of highly charged berylliumlike ions with inclusion of configuration mixing. Parks, A.D.; Sampson, D.H. (General Electric Company, Valley Forge Space Center, Valley Forge, Pennsylvania 19481). *Phys. Rev., A;* **15**: No. 4, 1382-1392(Apr 1977).

Electron-impact scaled collisions strengths $Z^2\Omega$ for a large number of transitions involving configuration-mixed initial and/or final states are obtained for berylliumlike ions in the limit Z yields ∞. These results are compared with the corresponding non-configuration-mixed results. It is found that the effect of configuration mixing is usually small (approximately-less-than30%) and nearly independent of impact electron energy, but in a very few cases it is large, resulting in a change in Ω by about a factor of 2. The results are expected to be of interest for applications to high-temperature plasmas containing moderately heavy elements.

33358 Effects of configuration and parentage mixing on inner-shell excitation of highly charged lithiumlike ions by electron impact. Sampson, D.H.; Parks, A.D.; Clark, R.E.H. (Department of Astronomy, The Pennsylvania State University, University Park, Pennsylvania 16802). *Phys. Rev., A;* **15**: No. 4, 1393-1406(Apr 1977).

Electron-impact scaled collision strengths $Z^2\Omega$ for a large number of inner-shell excitation transitions involving configuration-mixed and/or parentage-mixed upper levels are obtained for lithium-like ions in the limit Z yields ∞. Since this is the simplest case for which both parentage and configuration mixing occur, this problem is of intrinsic interest to the atomic physicist. The results are also expected to be of interest in applications to highly charged lithium-like ions occurring in high-temperature, low-density plasmas. The effects of mixing are found to be large in several cases. However, as for the unmixed results, the collision strengths can still be expressed in a simple way in terms of the scaled hydrogenic ion collision strengths $Z^2\Omega$/sub H/ and $Z^2\Omega$/sup e//sub H/.

33359 Angular-distribution measurements of K x-ray emission by 1-MeV/amu ions with 6 < or = Z < or = 9 following electron capture from helium. Ellsworth, L.D.; Guffey, J.A.; Salzborn, E.; Macdonald, J.R. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **15**: No. 4, 1438-1445(Apr 1977).

Angular distributions have been measured for the projectile K x rays emitted by highly ionized ions with 6 < or = Z < or = 9 incident on helium at MeV/amu energies. Polarization fractions have been determined by analysis of the data to include systematic consideration of the angular-dependent detector efficiency. For incident bare nuclei, a polarization fraction of 24.7 +- 1%, independent of energy and projectile atomic number, was observed for K radiation following electron capture to excited states. With incident one-electron ions, a Z-dependent polarization fraction was obtained, reaching a maximum of 40 +- 2% for oxygen ions. Lower-charge-state ions show decreasing values of P and the angular distributions approach isotropy for K x radiation from F^{+3} ions. For collisions of F^{+4} ions in argon, the Ar K radiation is isotropic within 2% uncertainty.

33360 Identification of the partial wave parameter and simplification of the differential cross section in the j/sub z/CCS approximation in molecular scattering. Parker, G.A.; Pack, R.T. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **66**: No. 7, 2850-2853(1 Apr 1977).

The identification of the partial wave parameter l-bar of the J/sub z/CCS approximation in molecular scattering theory is considered, and it is shown that if one chooses l-bar=l' (the final orbital angular momentum) rather than l-bar=J (the total angular momentum) the full body-fixed expression for the scattering amplitude reduces directly to the simple formula used by McGuire and Kouri. Results are cited that show that l-bar=l' is not only simple, but physically reasonable, and gives much better results than l-bar=J.

33361 Dynamics of CO_2^+-D_2 collisions. Mahan, B.H.; Schubart, P.J. (Materials and Molecular Research Division of the Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **66**: No. 7, 3155-3162(1 Apr 1977).

We have measured complete velocity vector distributions for several of the products of collisions between CO_2^+ and D_2. The reactions CO_2^+ $(D_2,D)DCO_2^+$ and CO_2^+ $(D_2,OD)DCO^+$ are the principal chemical processes in the range of relative energies from 1 to 15 eV. The former proceeds principally by a direct interaction mechanism, with some smaller contribution from the decay of a $D_2CO_2^+$ persistent complex. The DCO^+ appears to come exclusively from the decay of this persistent complex at low relative energies,

and from a complicated direct interaction process at very high energies. Other energetically accessible products such as CO^+, O^+, D_2O^+, and OD^+ prove to be of minor or no importance.

ATOMIC AND MOLECULAR THEORY

33362 Measurement of a quadrupole transition moment by interference of quadrupole and dc-field-induced sum-frequency generation. Bethune, D.S.; Smith, R.W.; Shen, Y.R. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **38**: No. 12, 647-649(21 Mar 1977).

We show that, by measuring the interference between quadrupole and dc-field-induced sum-frequency generation, both the magnitude and the sign of a quadrupole matrix element can be obtained relative to the dipole matrix elements in atomic transitions. We use the measurement of <3svertical-barz²vertical-bar4d< of sodium to demonstrate the technique.

33363 Theory of level splitting: Spectrum of the octahedrally invariant fourth-rank tensor operator. Fox, K.; Galbraith, H.W.; Krohn, B.J.; Louck, J.D. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **15**: No. 4, 1363-1381(Apr 1977).

The theory of level splitting of certain vibration-rotation states (including the ground state) in spherical-top molecules is developed within the framework of the standard Racah-Wigner tensor algebra, thus demonstrating the direct applicability of these general techniques without making the usual modifications associated with the anomalous commutation relations of the body-fixed angular momentum components. The eigenvalue spectrum of the octahedrally invariant fourth-rank tensor operator is examined in detail, and the unexpected periodic symmetry and asymptotic degeneracy features of the spectrum are described.

33364 Liquid ammonia: Molecular correlation functions from x-ray diffraction. Narten, A.H. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **66**: No. 7, 3117-3120(1 Apr 1977).

For nearly spherical molecules the x-ray scattering from liquids yields structure and correlation functions for molecular centers. The distribution of electron density in an ammonia molecular is very nearly spherical, and orientational correlation between molecules in the liquid is not "seen" by x rays. Structure and correlation functions for molecular centers (nitrogen atoms) are derived from x-ray data on liquid NH_3 at 4 degreeC and tabulated. They provide a sensitive test for future work on a molecular theory of liquid ammonia.

PROPERTIES AND STRUCTURE OF FLUIDS

33365 Existence of the dielectric constant in rigid-dipole fluids: The functional-derivative approach. Ramshaw, J.D. (Group T-3, Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **66**: No. 7, 3134-3138(1 Apr 1977).

In a previous article [J. Chem. Phys. 57, 2684 (1972)] sufficient conditions were established for the existence of the dielectric constant ϵ in rigid-dipole fluids. One of these conditions was an unrealistic restriction on the angular dependence of the direct correlation function c (12) at short range. Here it is shown that this restriction can be removed without altering the previous conclusions. Consequently, ϵ rigorously exists if c (12) depends only upon relative positions and orientations of molecules 1 and 2, and becomes asymptotic to -phi/sub d/(12)/kT at long range, where phi/sub d/(12) is the dipole—dipole potential. The development is based upon the functional-derivative interpretation of c (12) in terms of the response of the single-molecule distribution function to a single-molecule external field. The consequences of formally separating c (12) and the total correlation function h (12) into short- and long-range parts are briefly explored. A relation between the angular moments of the short-range parts of c (12) and h (12) is derived in an appendix.

MAGNETOHYDRODYNAMICS

REFER ALSO TO CITATION(S) 33457, 33458

33366 Two-dimensional compressional plasma flow in coaxial channel. Brushlinskii, K.V.; Morozov, A.I.; Paleichik, V.V.; Savel'ev, V.V. (Institute of Applied Mathematics, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 291-296(Jul 1976).

In an analysis of the plasma flow in coaxial channels accompanied by contraction and heating at the channel axis, the steady-state flow regimes are found through numerical integration of the two-dimensional unsteady MHD equaitons, with the Hall effect taken into account, until the establishment of a steady state. The compressional properties of the flow are studied as functions of the viscosity, thermal conductivity electrical conductivity, and Hall effect. A steady-state compressional-flow regime with a shock wave is found; the limiting transition to this regime in flows with small dissipation coefficients is studied.

SUPERFLUIDITY

33367 Experiments on the properties of superfluid helium in zero gravity. Mason, P. (Jet Propulsion Lab., Pasadena, CA); Collins, D.; Petrac, D.; Yang, L.; Edeskuty, F.; Williamson, K. pp 272-277 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976).

From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The research program described is the study of the behavior of superfluid liquid helium in low and zero gravity in order to determine those properties which are of importance to its use as a stored cryogen for cooling scientific instruments aboard spacecraft for periods up to several months. A number of long term missions requiring temperatures below 10°K are now in the planning stage. The first of these will be an infrared astronomy satellite (IRAS) to be flown in the early 1980s. It will conduct a complete survey of the sky in the spectral region between 8 and 200 micrometers. The detectors will require cooling to temperatures from 2 to 12°K, and the telescope will be cooled to 20°K. Although cooling could be obtained by Joule-Thomson expansion of supercritical helium, it appears more efficient to carry the cryogen in the form of superfluid helium (He II). A second mission under development is a gyroscope test of Einstein's general theory of relativity, also to be flown early in the next decade. Temperatures of about 1.8°K will be required to reduce thermal noise, permit superconducting magnetic shielding, superconducting magnetic bearings and London moment read-out of gyro position.

33368 Orienting action of an electric field on the directix of the superfluid B phase of liquid He^3. Gongadze, A.D.; Gurgenishvili, G.E.; Kharadze, G.A. (Physics Institute, Georgeian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **23**: No. 12, 622-624(20 Jun 1976).

It is shown that under the aggregate action of an electric and a magnetic field the equilibrium orientation of the directrix of the B Phase of superfluid He^3, at an intensity E<E/sub c/, should deviate from the direction of H, leading to a shift of the frequency of the transverse NMR.

OTHER QUANTUM FLUIDS

33369 Dynamic structure function of liquid ^3He. Lam, P.M.; Jackson, H.W. (Washington Univ., St. Louis, Mo. (USA). Dept. of Physics); Ristig, M.L. (Koeln Univ. (Germany, F.R.). Inst. fuer Theoretische Physik); Clark, J.W. (Argonne National Lab., Ill. (USA)). *Phys. Lett., A;* **58**: No. 7, 454-456(18 Oct 1976).

The dynamic structure function $S(Q,\omega)$ of liquid ^3He is evaluated in the impulse approximation, based on a theoretically calculated momentum distribution n(k). The gap of n(k) at the Fermi surface gives rise to discontinuities in the slope of $S(Q=\text{const.},\omega)$ which may be detectable in neutron- or γ-ray scattering experiments.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

WEAK INTERACTIONS

33370 New measurements of the spin-electron angular correlation in the decay of polarized neutrons. Erozolimskii, B.G.; Frank, A.I.; Mostovoi, Y.A.; Arzumanov, S.S. *JETP Lett. (USSR) (Engl. Transl.);* **23**: No. 12, 663-669(20 Jun 1976).

The decay of polarized neutrons obtained from the IRT-M reactor was studied to determine the ratio of the fundamental weak-interaction constants.

33371 Diffractive production of rho mesons by 147-GeV muons. Francis, W.R.; Anderson, H.L.; Bharadwaj, V.K.; Booth, N.E.; Fine, R.M.; Gordon, B.A.; Heisterberg, R.H.; Hicks, R.G.; Kirk, T.B.W.; Kirkbride, G.I.; Loomis, W.A.; Matis, H.S.; Mo, L.W.; Myrianthopoulos, L.C.; Pipkin, F.M.; Pordes, S.H.; Quirk, T.W.; Shambroom, W.D.; Skuja, A.; Verhey, L.J.; Williams, W.S.C.; Wilson, R.; Wright, S.C. (Enrico Fermi Institute and Departmet of Physics, The University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **38**: No. 12, 633-636(21 Mar 1977).

Cross sections for diffractive rho muoproduction in hydrogen are presented for 90 GeV $<\nu<$135 GeV (where ν is the energy lost by the scattered muon) and $Q^2<5$ (GeV/c)^2. The results are compared with lower-energy data and the predictions of simple vector-dominance models.

STRONG BARYON-INDUCED INTERACTIONS

33372 Atomic-number dependence of large-transverse-momentum hadron production by protons. Kluberg, L.; Piroue, P.A.; Sumner, R.L.; Antreasyan, D.; Cronin, J.W.; Frisch, H.J.; Shochet, M.J. (Department of Physics, Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **38**: No. 13, 670-673(28 Mar 1977).

We have measured at Fermilab the production of hadrons at ~90degree in the c.m. system as a function of incident proton energy, atomic number A of the production target, and the transverse momentum p/sub perpendicular/ of the produced hadron. The A dependence of the production cross section of the hadrons can be described by a function A/sup α//sup(p/perpendicular)/sup /, where the power α rises with p/sub perpendicular/. At p/sub perpendicular/~5 GeV/c, α is ~1.1 for π/sup plus-or-minus/ and K^+, and ~1.3 for p, p-bar, and K^-. The energy dependence of the power is also measured.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 33372

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

33373 Behavior of the wave function at short distances and blocking of quarks. Skachkov, N.B. (Joint Institute for Nuclear Reseach). *JETP Lett. (USSR) (Engl. Transl.);* **23**: No. 12, 657-659(20 Jun 1976).

The relative motion of quarks is described in a relativistic coordinate space, the transition to which is realized with the aid of an expansion of the wave function on the Lorentz group. It is shown that inclusion of an additional series of unitary representations in this expansion leads in natural fashion to a potential that traps the quarks.

33374 Gauge invariance, time-dependent Foldy-Wouthuysen transformations, and the Pauli Hamiltonian. Goldman, T. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **15**: No. 4, 1063-1067(15 Feb 1977).

The Foldy-Wouthuysen derivation of the generalized Pauli Hamiltonian is reexamined, and described as an operator gauge transformation. The unitary inequivalence of the Pauli and Dirac Hamiltonians is shown to occur, because in general it is only the entire coupled field Hamiltonian which is gauge invariant, not the particle Hamiltonian alone.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 33311

33375 Multiply charged magnetic monopoles, SU(3) pseudoparticles, and gravitational pseudoparticles. Marciano, W.; Pagels, H.; Parsa, Z. (Department of Physics, The Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **15**: No. 4, 1044-1049(15 Feb 1977).

We demonstrate how the finite-energy unit magnetic monopole of an SU(2) gauge theory generalizes to configurations with multiple magnetic charge when properly embedded in higher-rank gauge theories. Masses and stability properties of these topologically distinct solutions are discussed. This same generalization is shown to hold for the pseudoparticle solution of Euclidean Yang-Mills theories. Finally, properties of the gravitational pseudoparticle solutions to the Einstein field equations are exhibited and discussed.

33376 Electric- and weak magnetic-dipole-moment effects in e^+e^- yields l^+l^-. Budny, R.; Kayser, B.; Primack, J. (Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **15**: No. 5, 1222-1226(1 Mar 1977).

We consider the weak effects in e^+e^- yields l^+l^- that come, not from neutral currents, but from possible muon or heavy-lepton electric dipole moments, and from weak corrections to magnetic dipole moments. We show that in the coming experiments on this reaction, these weak effects can safely be ignored.

33377 Reaction rate, weak corrections, and background in e^+e^- yields $\pi^0\gamma$,etaγ. Dicus, D.A.; Kolb, E.W.; Teplitz, V.L. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). *Phys. Rev., D;* **15**: No. 5, 1286-1292(1 Mar 1977).

The e^+e^- yields $\pi^0\gamma$,etaγ cross sections at high energies are computed on the basis of resonance-pole and quark-loop approximations. A sizable difference is found between the results of these two models; this makes the measurement one of importance especially for detection of charmed, and heavier, quarks. The effects of beam polarization are included, as are the weak (neutral-current) corrections. The weak corrections are, in most weak-interaction models, relatively small. The 3γ background is also computed including the effects of beam polarization. It is large and there does not seem to be an easy way of using beam-polarization effects to suppress it.

33378 Multiplicities in hadronic and current-induced reactions. Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **15**: No. 5, 1306-1313(1 Mar 1977).

Mean multiplicities of hadrons in hadron-hadron collisions and in current-induced reactions are discussed. It is argued that we have to consider one of three possibilities: (1) A more rapid growth with lns of multiplicities in e^+e^- annihilations than in hadronic collisions. (2) Violations of constituent-counting rules for exclusive cross sections. (3) Substantially different clustering properties of hadrons in e^+e^- annihilations than in hadronic collisions.

33379 Upper and lower bounds on weak-intermediate-boson masses. Bjorken, J.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **15**: No. 5, 1330-1340(1 Mar 1977).

Under a rather general class of assumptions, the most important being that weak and electromagnetic interactions are based upon a spontaneously broken gauge theory with an underlying simple gauge group, we estimate bounds on the least massive charged boson. Typical values lie between 55 and 75 GeV, in agreement with those estimated from the Weinberg-Salam SU(2) x U(1) model. Less restrictive bounds are obtained for neutral bosons Z^0.

33380 Static and transition magnetic moments of charmed baryons in the quark model. Johnson, R.J.; Shah-Jahan, M. (Physics Department, Indiana University, Bloomington, Indiana 47401). *Phys. Rev., D;* **15**: No. 5, 1400-1402(1 Mar 1977).

We obtain expressions for the static and transition magnetic moments of charmed baryons in the quark model. Our results reduce to those of previous calculations as special cases.

33381 D^{0*}yields$D^0\gamma$ and other radiative decays of vector mesons. Bohm, A.; Teese, R.B. (Center for Particle Theory, Physics Department, University of Texas at Austin, Austin, Texas 78712). *Phys. Rev. Lett.;* **38**: No. 12, 629-632(21 Mar 1977).

With use of SU(4) as a spectrum-generating group, the radiative decay rates of the charmed vector mesons and of J (psi) are calculated. With the known decay rates of the "old" mesons Γ (ωyields$\pi\gamma$), Γ (phiyieldsetaγ), Γ (rhoyields$\pi\gamma$), and Γ (K^{0*}yields$K^0\gamma$) as input, one obtains Γ (K^{+*}yields$K^+\gamma$) =2.6 keV, Γ (ωyieldsetaγ) =220 eV, Γ (rhoyieldsetaγ) =4.8 keV, Γ (psiyieldsxγ) =1.6 keV, Γ (D^{0*} yieldsD$^0\gamma$) =350 eV, and Γ (D^{+*}yieldsD$^+\gamma$) =22 eV.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 33311, 33376, 33379

33382 Test of nonconfinement through a neutral-current scattering experiment. Mohapatra, R.N.; Pati, J.C.; Sidhu, D.P. (City College of City University of New York, New York, New York 10031). *Phys. Rev., D;* **15**: No. 5, 1240-1245(1 Mar 1977).

It is remarked that within the gauge theory of physical color (integer-charge quarks), one expects to see significant rises in neutral-current parameters (40—45 % in σ/sup ν//sub NC/, 60—65 % in σ/sub NC//sup nu-bar /, 20 % in R/sub ν/, and 10 % in R/sub nu-bar/) due to color excitation above color threshold. This pattern of rises is characteristic of the color-excitation hypothesis alone; it cannot be attributed to new-flavor excitation within the gauge framework. It is pointed out that within the constraints of renormalizable gauge interactions new-flavor excitation may [under very special circumstances involving an extension of the SU(2)/sub w/ x U(1) gauge structure] lead to rises in the neutral-current parameters; however, the corresponding pattern of rises (i.e., rises in νN versus nu-barN) is distinct from that due to color excitation.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 33378

33383 Toward quantization of a "three-string". Sundermeyer, K.; de la Torre, A. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **15**: No. 6, 1745-1755(15 Mar 1977).

The linearized classical equations of motion for a system of three relativistic strings, which are coupled at a junction, are solved.

The system is quantized covariantly and general features of the spectrum of states are explored.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 33379

33384 Effective strong-interaction Lagrangian. Mirelli, V.; Schechter, J. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **15**: No. 5, 1361-1367(1 Mar 1977).

We discuss the current-algebra treatment of the basic quark-model Lagrangian, which contains in addition the simplest (from a group-theoretical point of view) effective term that can solve the U(1) problem. Reasonable experimental agreement is found for the relevant pseudoscalar masses. It is shown how the σ-model solution for the masses is mapped into a whole family of solutions in this generalized quark-model case. A possible way of consistently getting Gell-Mann—Okubo—type mass relations while not going to the approximation of an exactly symmetric vacuum is pointed out. This leads to a simple relation among the pseudoscalar-meson decay constants.

33385 Quantitative understanding of rho' (1600) and the suppression of its two-pion decay mode from dual resonance models. Odorico, R. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **15**: No. 5, 1384-1386(1 Mar 1977).

A family of resonance states of the generalized Veneziano model, enjoying special stability properties due to the suppression of the lower-multiplicity decay modes, is presented. The lightest of these states, having decay multiplicity two suppressed, agrees in mass and spin with rho' (1600). Masses and spins of the heavier states, for which higher decay multiplicities are affected, are also uniquely determined.

33386 Relativistic two-body wave equation and meson spectrum. Suura, H. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev. Lett.;* **38**: No. 12, 636-639(21 Mar 1977).

The meson spectrum is studied with use of an equal-time relativistic two-body equation with electrostatic confinement potentials. A normalizability condition excludes all but a bag solution which gives a spectral pattern in between the SU(6) and the chiral SU(3) xSU(3) limits. Orbital mixing creates a pair of $^3S_1 + {}^3D_1$ states sandwiching the $^1P_1$ level. rho-rho' and psi/J=psi' pairs fit this picture very well.

STRONG INTERACTIONS, BARYON NO.=1

33387 Polarization effects in π^{+-}p scattering at high energies. Troshin, S.M.; Tyurin, N.E. (Institute of High-Energy Physics). *JETP Lett. (USSR) (Engl. Transl.);* **23**: No. 12, 660-663(20 Jun 1976).

Within the framework of the generalized reaction-matrix method, we analyze the polarization in π^{+-}p scattering at high energies. The contribution resulting directly from vacuum eschange is considered.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

33388 Low-momentum K^+d scattering. Glasser, R.G.; Snow, G.A.; Trevvett, D.; Burnstein, R.A.; Fu, C. ; Petri, R.; Rosenblatt, G.; Rubin, H.A. (University of Maryland, College Park, Maryland 20742). *Phys. Rev., D;* **15**: No. 5, 1200-1214(1 Mar 1977).

The differential cross sections for K^+d coherent, breakup, and charge-exchange scattering have been measured at several momenta in the interval 250—600 MeV/c. The data have been fitted using a partial-wave analysis. Assuming an s-wave description of I = 1 scattering and using data from the coherent and charge-exchange channels, a description of I = 0 K^+-N scattering by a combination of s and p waves in a simple single-scattering impulse model has been attempted. The phase shifts obtained are unique up to the Fermi-Yang ambiguity, which can be removed by using existing polarization results at 600 MeV/c.

33389 Rapidity correlations in pp collisions at 102 and 400 GeV/c. Bromberg, C.; Ferbel, T.; Slattery, P.; Seidl, A.; VanderVelde, J.C. (University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **15**: No. 5, 1215-1221(1 Mar 1977).

We present a study of two-particle rapidity correlations in inclusive and semi-inclusive reactions in pp collisions at 102 and 400 GeV/c. In particular, we examine the charge, multiplicity, and s dependence of these correlations. Our inclusive data provide evidence for the presence of energy-independent short-range correlations in rapidity. Significant contributions to these correlations arise from data having high multiplicities. Correlations among particles of like charge are weaker than among particles of opposite charge.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 33382

33390 Nondiagonal neutral currents in inclusive neutrino interactions. Aubrecht, G.J. II; Takasugi, E.; Tanaka, K. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **15**: No. 5, 1246-1253(1 Mar 1977).

We examine the effects of nondiagonal terms in the neutral current of an SU(2) x U(1) gauge six-quark model with slow rescaling. The model reproduces the experimental charged-current data with appropriate choice of heavy-quark masses. At least five quarks are required to explain the experimental neutral-current data. In our context, the predictions for various heavy-quark masses and quark mixings differ most for energies in the range 0—50 GeV. The various quantities are also calculated for proton and neutron targets.

33391 Mixing of neutral charmed mesons and tests for CP violation in their decays. Goldhaber, M.; Rosner, J.L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **15**: No. 5, 1254-1259(1 Mar 1977).

The reactions e^+e^- yields D^0D-bar^0 + m (π^0) + n (γ), followed by decays of the charmed mesons to eigenstates of CP, satisfy selection rules which allow tests of CP invariance. When the e^+e^- reactions proceed through one virtual photon and n is even (odd), the decay products of the two neutral charmed mesons will have opposite (equal) CP to the approximation in which CP is conserved. Final states with even CP include $\pi\pi$ and, approximately, K^0/sub L/π^0, the final state K^0/sub S/π^0 is nearly CP-odd. It is shown that when both neutral charmed mesons decay to identical final states, the signal for CP violation always contains a factor related to the amount of D^0-D-bar^0 mixing, and hence is small if this mixing is small (as in the standard charm model). When two different final states are observed, the signal for CP violation contains such a factor only in certain models, of which the superweak model is an example.

33392 Charmed-meson production and decay using vector-meson dominance and dual-amplitude analysis. McKay, D.W.; Young, B. (Ames Laboratory: ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **15**: No. 5, 1282-1285(1 Mar 1977).

Two prominent features of the data on the charmed-meson—type signal observed at SPEAR are discussed. The predominance of the DD-bar* production and the lack of a pronounced K* production signal in D^+ yields $K^-\pi^+\pi^+$ are explained by using ideas borrowed from analysis of the production and decay of low-mass, uncharmed mesons. The e^+e^- production cross sections for charmed-meson pairs are treated by a simple vector-meson-dominance picture, and approximate SU(4) symmetry for PPV and PVV couplings leads to a factor-25 enhancement of the DD-bar* channel compared to the DD-bar channel. The nonleptonic decay D^+ yields $K^-\pi^+\pi^+$ is represented by a model with a $\Delta S = \Delta C$ effective weak "mass-mixing" Hamiltonian, with pole dominance of the external legs, and with Veneziano-amplitude representation of the meson-meson off-shell scattering amplitude. There is no pronounced K* signal in this model, a result which is independent of the choice of satellite terms in the Veneziano amplitude. The potential usefulness of dual-amplitude fits of three-body nonleptonic charmed-meson decays in studies of meson-meson interactions in the 1—2-GeV range is emphasized. The striking charmed-meson mass relations derived from the single-term Veneziano amplitude plus Adler PCAC (partial conservation of axial-vector current) condition (e.g., M D-italic /sub asterisk/ = 2.017 +- 0.02 GeV is predicted with M/sub D/ = 1.87 +- 0.015 GeV as input) lend support to this kind of approach.

33393 Mechanism for nonconservation of muon number. Bjorken, J.D.; Weinberg, S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **38**: No. 12, 622-625(21 Mar 1977).

We consider the possibility that muon-number conservation is not a fundamental symmetry of nature. In simple SU(2) xU(1) gauge theories with several scalar boson doublets, muon number will still automatically be conserved by the intermediate-vector-boson interactions, but not by effects of virtual scalar bosons. The branching ratio for $\mu + e + \gamma$ is estimated to be of order $(\alpha/\pi)^3$. Other μ-ϵ transition processes are also discussed.

APPLICATIONS TO STRONG INTERACTIONS

REFER ALSO TO CITATION(S) 33384, 33390

33394 Calculating hadronic cross sections in specific symmetry schemes: An application to the psip total cross section. Aubrecht, G.J

II; Dash, J.W.; Razmi, M.S.K.; Teper, M. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **15**: No. 5, 1322-1329(1 Mar 1977).

We construct a model for calculating ratios of cross sections. We apply the model to SU(3), calculating σ/sub K p//σ/sub π// sub p/, and then to SU(4), in order to estimate the psip cross section. Results are obtained in both "pure" and broken SU(4). The energy dependence of σ/sub psi p/ and the slope of the psip differential cross section are qualitatively discussed. Kinematic effects arising from mass splittings and t/sub min/ effects are crucial.

FIELD THEORY

REFER ALSO TO CITATION(S) 33375

33395 Unification of supergravity and Yang-Mills theory. Freedman, D.Z.; Schwarz, J.H. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., D;* **15**: No. 4, 1007-1012(15 Feb 1977).

Supersymmetric Yang-Mills theory (including the Abelian case) is combined with supergravity so as to achieve local supersymmetry. The Lagrangian, the supersymmetry transformation rules, and their commutator algebra are presented.

33396 Point transformations and renormalization in the unitary gauge: Renormalization effects. Sherry, T.N. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **15**: No. 4, 1068-1072(15 Feb 1977).

We continue an analysis of two simple gauge theory models using point transformations rather than gauge transformations. The renormalization constants are examined directly in two gauges, the renormalization (Landau) and unitary gauges. Our result is that the individual coupling-constant renormalizations are identical when calculated in each of the above two gauges, although the wave-function and proper vertex renormalizations differ.

33397 Lattice gauge theories and the continuum limit in two dimensions. Roth, M.W. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **15**: No. 4, 1084-1093(15 Feb 1977).

Lattice gauge theories in two dimensions are studied with regard to investigating the continuum limit. The effective interaction is calculated for the lattice gauge theories for QED [U(1)] and SU(N) to all orders in the gauge coupling and is shown to reproduce the usual Schwinger and 't Hooft models, respectively, in the limit of zero lattice spacing. However, lattice gauge theories in strong coupling have, in general, qualitatively different S matrices than their expected continuum analogs. Except for the SU(N) lattice gauge theory in the formal limit N yields ∞, g^2N fixed, the lattice introduces additional four-or-more-body forces which are not present in the continuum.

33398 New approximation schemes for lattice theories. Savit, R. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **15**: No. 4, 1094-1110(15 Feb 1977).

We describe a class of approximation procedures which is applicable to a variety of lattice theories including lattice gauge theories. The approach is nonperturbative in the temperature or its inverse. The low-order approximants are expected to be most reliable at low temperatures. As examples we approximate the free energy of the classical x-y model and of Abelian gauge fields on a lattice in two ways, one of which gives us monotonically converging bounds on the free energy.

33399 Gauge fixing, the transfer matrix, and confinement on a lattice. Creutz, M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **15**: No. 4, 1128-1136(15 Feb 1977).

We use the transfer-matrix formalism of statistical mechanics to relate Wilson's Lagrangian approach and the Kogut-Susskind Hamiltonian approach to gauge theories on a lattice. As a preliminary we discuss gauge fixing in Wilson's theory. This process leaves invariant Green's functions of gauge singlet operators. Taking the timelike lattice spacing to zero, we extract the Kogut-Susskind Hamiltonian from the transfer matrix in the gauge $A_0 = 0$.

33400 Reduction of field equations and saturated bounds for vortex-line theories. Hietarinta, J. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **15**: No. 4, 1137-1140(15 Feb 1977).

The Euler-Lagrange equations following from the two-dimensional Higgs-type Lagrangian and from the chirally nonlinear Lagrangian are shown to be reducible to one second-order differential equation. This simplification is possible for an arbitrary configuration of static parallel vortex lines but only for a specific potential. In both cases the result is connected with a saturated bound for the energy and also with conditions arising from the scale variation.

33401 Stress-tensor trace anomaly in a gravitational metric: Scalar fields. Brown, L.S. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., D;* **15**: No. 6, 1469-1483(15 Mar 1977).

We compute the stress-tensor vacuum expectation value of a massive, scalar quantum field that is coupled to the metric of an arbitrary classical gravitational field. The renormalized tensor is defined by a dimensionally continued, proper-time representation. The stress tensor is calculated for arbitrary dimension in a potentially conformal-invariant manner so that its trace is formally proportional to the square of the scalar-field mass with this trace vanishing as the scalar field becomes massless. However, the renormalized stress tensor violates this formal identity with its trace containing additional, anomalous terms. These finite-trace anomalies are intimately related to the infinite counterterms that must be put into the action to make the stress tensor finite.

33402 Properties of a 20-component spin-1/2 relativistic wave equation. Khalil, M.A.K. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **15**: No. 6, 1532-1539(15 Mar 1977).

A new 20-component relativistic wave equation is studied. It is shown that this manifestly Lorentz-covariant equation describes particles with unique mass m and spin 1/2. A nonsingular eta matrix is also shown to exist. The free wave equation is equivalent to the Dirac equation, but when a minimally coupled external electromagnetic field is introduced the new equation behaves differently from the Dirac equation. For example, the magnetic moment of a particle described by the 20-component equation depends on a free parameter and can thus take on any value including zero. The proposed equation is irreducible and the Γ/sub μ/ matrices satisfy a fourth-order minimal algebra, and thus Γ_0 is nondiagonalizable. Previously, examples of irreducible wave equations with nondiagonalizable Γ_0, that could continue to propagate causally in an external field, were not known. The equation proposed here is an example of such a theory.

33403 New approach to the calculation of $F_1(\alpha)$ in massless quantum electrodynamics. Bender, C.M.; Keener, R.W.; Zippel, R.E. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **15**: No. 6, 1572-1579(15 Mar 1977).

$F_1(\alpha)$ is defined as the contribution of the one-fermion-loop diagrams to the divergent part of the photon propagator in massless quantum electrodynamics. To sixth order, the perturbation expansion of $F_1(\alpha)$ has rational coefficients: $F_1(\alpha) = (2/3)(\alpha/2\pi) + (\alpha/2\pi)^2 - (1/4)(\alpha/2\pi)^3 + x\,x\,x$. It is not known whether the next term in this series is a rational number; however, we propose a new method, which uses integration by parts, for evaluating Feynman integrals which give rational numbers. Using this method we easily rederive the first three terms in the series for $F_1(\alpha)$ and three other two-loop integrals, including the fourth-order correction to the vertex function Γ/sup μ/(p,p). We believe that our new integration techniques are powerful enough to evaluate the fourth term in the series for $F_1(\alpha)$ if it is a rational number.

33404 Renormalization group and the infrared behavior of gauge theories. Poggio, E.C.; Quinn, H.R.; Zuber, J.B. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **15**: No. 6, 1630-1641(15 Mar 1977).

This paper discusses the application of renormalization-group techniques to the study of the near-mass-shell behavior in gauge theories with fermions. We critically review past work for the Abelian theory of quantum electrodynamics (QED), and also summarize what is known from perturbative analysis. We reformulate the renormalization-group equation in a way which is acceptable to the infrared region and discuss the subsidiary requirements necessary to obtain useful results from this equation. Our analysis is cast in a framework which avoids any dependence on the simple group structure of QED and is thus suitable for generalization to the non-Abelian case. A full discussion of that case is reserved for a later paper, but we present here some discussion of the differences which arise and the modifications which they necessitate in our analysis.

33405 Conformal properties of pseudoparticle configurations. Jackiw, R.; Nohl, C.; Rebbi, C. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **15**: No. 6, 1642-1646(15 Mar 1977).

The known Euclidean Yang-Mills pseudoparticle solutions with Pontryagin index n are parametrized by 5n constants describing the size and location of each pseudoparticle. By insisting on conformal covariance of the solutions, we show that more general solutions exist: they are parametrized by 5n + 4 constants. We further demonstrate that the additional degrees of freedom are not gauge artifacts and correspond to a new degeneracy of pseudoparticle configurations.

33406 Theory of Dirac monopoles with a non-Abelian symmetry. Ezawa, Z.F.; Tze, H.C. (Laboratoire de Physique Theorique et Particules Elementaires, Universite de Paris XI, 91405 Orsay, France). *Phys. Rev., D;* **15**: No. 6, 1647-1654(15 Mar 1977).

From the viewpoint of a global formulation of Yang-Mills fields, a Lagrangian theory of non-Abelian classical Dirac monopoles is proposed. Dirac strings are used instead of coordinate patches; they are defined as purely geometric constructs. The formalism is free from pathologies such as "Dirac's veto." While the analysis focuses on the gauge group SU(N)/Z/sub N/ allowing for only N - 1 nontrivial and topologically distinct types of monopoles, it applies in general to any compact Lie group.

33407 Renormalization of a distorted gauge-invariant theory. Hsu, J.P.; Underwood, J.A. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). *Phys. Rev., D;* **15**: No. 6, 1668-1674(15 Mar 1977).

We consider a new type of renormalizable theory involving massive Yang-Mills fields whose mass is generated by an intrinsic breakdown of the usual local gauge symmetry. However, the Lagrangian has a distorted gauge symmetry which leads to the Ward-Takahashi (WT) identities. Also, the theory is independent of the gauge parameter ζ. We completely carry out an explicit renormalization at the one-loop level by exhibiting counterterms, defining the physical parameters, and computing all renormalization constants to check the WT identities. Our results indicate that the physical scalar can be removed from the physical spectrum and that perhaps the theory could become asymptotically free.

33408 Fermion-field nontopological solitons. Friedberg, R.; Lee, T.D. (Barnard College and Columbia University, New York, New York 10027). *Phys. Rev., D;* **15**: No. 6, 1694-1711(15 Mar 1977).

The interaction between a scalar field and a set of n fermion fields in three space dimensions is investigated by decomposing the total Hamiltonian H into a sum of two terms: H = H/sub qcl/ + H/sub corr/, where H/sub qcl/ denotes the quasiclassical part and H/sub corr/ the quantum correction. General theorems are given for H/sub qcl/ concerning the existence of soliton solutions, the general properties of such solutions, and the condition under which the lowest energy state of H/sub qcl/ is a soliton solution, not the usual plane-wave solution. The effects of the quantum-correction term H/sub corr/ are examined. It is shown that the quasiclassical solution is a good approximation to the quantum solution over a wide range of the coupling constant. The approximation becomes very good when the fermion number N is large. Even for small N (2 or 3) and weak coupling, the quasiclassical solution remains a fairly good approximation. In the strong-coupling region and for arbitrary N, the quasiclassical approximation becomes again very good, at least when the fermions are nonrelativistic. The question whether the relativistic quantum field theory has a strong-coupling limit or not is not resolved.

33409 Energy-momentum-tensor trace anomaly in spin-1/2 quantum electrodynamics. Adler, S.L.; Collins, J.C.; Duncan, A. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **15**: No. 6, 1712-1721(15 Mar 1977).

We relate the energy-momentum-tensor trace anomaly in spin-1/2 quantum electrodynamics to the functions $\beta(\alpha)$, $\delta(\alpha)$ defined through the Callan-Symanzik equations, and prove finiteness of θ/sub μ//sub ν/ when the anomaly is taken into account.

33410 Implications for gauge theories if search for parity nonconservation in atomic physics fails. Mohapatra, R.N.; Sidhu, D.P. (Department of Physics, The City College of The City University of New York, New York, New York 10031). *Phys. Rev. Lett.;* **38**: No. 13, 667-670(28 Mar 1977).

Failure to detect parity-nonconserving effects in atomic transitions coupled with the available neutrino neutral-current data would appear to rule out all SU(2) xU(1) gauge theories which respect "natural" conservation laws for charm and strangeness and quark-lepton symmetry. We analyze a left-right symmetric "natural" (in the above sense) and quark-lepton symmetric SU(2)/sub L/ xSU(2)/sub R/xU(1) gauge theory and find that it accommodates all the features of neutral-current phenomena.

SCATTERING THEORY

33411 Arrangement-channel quantum mechanics: A general time-dependent formalism for multiparticle scattering. Kouri, D.J.; Krueger, H.; Levin, F.S. (Max-Planck-Institut fur Stroemungsforschung, Abteilung Molekulare Wechselwirkungen, Goettingen, Federal Republic of Germany). *Phys. Rev., D;* **15**: No. 4, 1156-1171(15 Feb 1977).

A general time-dependent formulation of many-body, multichannel scattering using the channel-coupling-array theory is presented. The formalism is based on the use of the channel-component states, previously introduced by Hahn, Kouri, and Levin. These states obey a set of non-Hermitian matrix equations, the non-Hermiticity arising from the presence of the channel-coupling array W. Despite the lack of Hermiticity, it is shown that the eigenvalues will always be real if the channel-component states obey a fixed-phase convention under time reversal. Use of the channel-component states leads in a straightforward way to an interaction picture and a single S operator. The analog of the usual two-body (single-channel) result connecting the time-dependent and time-independent descriptions is demonstrated. It is also shown that the channel-component states have the remarkable property that only the component in channel j gives rise to (two-body) outgoing waves in that channel: Components in channels m not-equal j do not yield outgoing waves in channel j. This is explicitly seen from the time-dependent development, but is inherent in the time-independent description. Such a property is known for the Faddeev decomposition in the three-body case; the present work extends and generalizes this result for the case of an arbitrary number of particles. In particular, the present formulation is seen to yield precisely the Faddeev equations for the three-body problem.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

33412 (ORO—3624-17) **North Carolina State University nuclear structure research at the Triangle Universities Nuclear Laboratory. Progress report, September 1, 1976—March 31, 1977.** Seagondollar, L.W.; Waltner, A.W.; Mitchell, G.E.; Tilley, D.R.; Dittrich, T.; Wender, S.A. (North Carolina State Univ., Raleigh (USA)). 12 Jan 1977. Contract EY-76-S-05-3624. 58p. Dep. NTIS $4.50.

Research during the period September 1, 1976 to March 31, 1977, is summarized in a number of brief reports. Many are only the abstracts of published articles; others are somewhat longer and contain some data. The reports are grouped under the following headings: neutron physics, high-resolution studies, gamma-ray spectroscopy, radiative capture reactions, atomic collision physics, heavy-ion reactions, accelerator development and instrumentation, and computer-related developments. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

REFER ALSO TO CITATION(S) 33300

NUCLEAR REACTIONS AND SCATTERING

33413 Direct evidence for a new giant resonance at $80A^{-1/3}$ MeV in the lead region. Harakeh, M.N.; van der Borg, K.; Ishimatsu, T.; Morsch, H.P.; van der Woude, A.; Bertrand, F.E. (Kernfysisch Versneller Instituut, Groningen, The Netherlands). *Phys. Rev. Lett.;* **38**: No. 13, 676-679(28 Mar 1977).

Inelastic α scattering experiments at 120 MeV on ^{206}/sup ,/ ^{208}Pb, ^{197}Au, and ^{209}Bi reveal the existence of a new isoscalar resonance located at $\sim 80A^{-1/3}$ MeV in addition to the well-known resonance at $\sim 63A^{-1/3}$ MeV. The angular distribution of this new resonance, though not inconsistent with an E4 assignment, is better described by E0 or E2. It would exhaust approximately 100%, 50%, or 17% of the corresponding isoscalar E0, E2, or E4 energy-weighted sum rules, respectively.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

33414 Two-quasiparticle and single-phonon states of even—even deformed nuclei in the region of the actinides. Ivanova, S.P.; Komov, A.L.; Malov, L.A.; Solov'ev, V.G. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **7**: No. 2, 175-191(Apr 1976).

Low-lying two-quasiparticle and single-phonon states of even—even nuclei are described in a wide range of the actinides (228< or =A< or =260) on the basis of the semimicroscopic approach. A study is made of role of anharmonic effects and it is shown that in a number of cases the two-phonon components make a large contribution to the structure of the first and second vibrational states. The experimental data are analyzed and compared with the results of theoretical calculations.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

SPONTANEOUS AND INDUCED FISSION

33415 (FEI—543) **ν bar dependence for ranium 233, uranium 238 and plutonium 239 from neutron energy to 5 MeV.** Nurpeisov, B.; Volodin, K.E.; Nesterov, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1974. 20p. (In Russian). NTIS (US Sales Only).

21 refs.; 7 figs.; 3 tables.

The dependence of the mean yield value of prompt fission neutrons has been studied for ^{233}U, ^{238}U and ^{239}Pu at the incident neutron energy up to 5 MeV. The T(p, n) and D(d, n) reactions and solid TT and DT targets on molybdenum substrates have been used in the experiment on an electrostatic and a cascade generators. The experimental facility makes it possible to measure the neutron yield per a fission act simultaneously for the three isotopes and the reference one - ^{252}Cf. ^{3}He counters with an addition of 2% of CO_2 are used. The time resolution of the neutron detector is 2.5 mcs. The detectors are placed within the shield that is coaxial with the collimator forming the bombarding neutron beam. The neutrons used and background neutrons are detected during the coincidence circuit gate length T. Background neutrons (chance coincidences) are accounted for by simultaneous pulse counting during the same time interval T but delayed relative to the gate pulse for 250 mcs. Contribution of the fission cross-section by delayed neutrons has been evaluated by two methods: 1) comparing the number of fissions for ^{233}U, ^{239}Pu, and ^{235}U in the beam and in the collimator shadow and 2) comparing the ratio of number of fissions for the isotopes inside and outside the shield. The measurements show the background to be from 3 to 5% for unthreshold isotopes. The experimental results show the breaking of the linear dependence of the mean yield value of prompt neutrons versus the incident neutron energy to be a systematically observed phenomenon that is necessary to be accounted for in solving applied problems, preparing reactor many-group constants, in particular. The experimental results are presented showing the mean energy if incident neutrons, number of measurement cycles (about 1.5 thousand real coincidence in each) for each isotope mentioned. The correction factor structure and experimental errors are considered for 2.0 MeV neutrons.

NUCLEAR THEORY

33416 (BNL-tr—644) **Green's function as a quantitative tool in nuclear theory.** Migdal, A.B. [nd]. Translated by S.J. Amoretty from pp 475-500 of Voprosy fiziki elementarnykh chastits, Publishing House of the Academy of Sciences, Erevan, 1964. 49p. Dep. NTIS $4.00.

Although all of the most interesting nuclear effects were studied quantitatively within the framework of simple physical models, general quantitative results can be obtained only from a more unified treatment because the interaction between nucleons is far from weak. The Green's function method, which represents such an approach, yields graphs that vary slowly near the Fermi limit; in the case of small excitations they can be replaced by constants. In the nuclear case, the effective (local) interaction is characterized by many constants that are the same for all nuclei and all types of transition. These constants, which are directly proportional to the constant mass density of nuclear matter, are taken from experiments, since their calculation is impossible without recourse to approximate methods. The theory is specifically used for justification of the shell model, description of the many-body systems in terms of the Green's function, discussion of nuclei in external fields and the equation for the effective field within the nucleus, derivation of the effective field in pairwise correlation, and formulation of interactions between quasiparticles. Deduction from experimental data concerning the interaction amplitudes, stability conditions for nuclear matter, omission of quadrupole-quadrupole interactions within nuclei, changes occurring in the density matrix as a result of adding particles, variation of the density matrix in strong fields, quantum jumps in the radius and shape of the nucleus, shifts in nuclear boundaries as a result of excitation or addition of particles, magnetic moments, moments of inertia, transition probabilities, and the dipole photoelectric effect are discussed. Future tasks of the theory are outlined.

NUCLEAR STRUCTURE

33417 **Quasiclassical theory of nuclear shell structure.** Strutinskii, V.M.; Magner, A.G. (Institute of Nuclear Research, Academy of Sciences of the Ukrainian SSR, Kiev). *Sov. J. Particles Nucl. (Engl. Transl.);* 7: No. 2, 138-163(Apr 1976).

The quasiclassical approximation for the density of single-particle levels based on Feynman path integrals is extended to the case of degenerate classical motion. It is shown that the appreciable fluctuations (gross shells) in the density of the single-particle levels correspond to quasiclassical quantization of the motion in multidimensional periodic orbits. Formal estimates are obtained for the scale and period of the oscillations of the single-particle level density, the level density of an excited nucleus, and the shell corrections to the binding energies and deformation energies of nuclei. The connection between the classical theory and the method of numerical averaging is discussed.

33418 **Determination of lifetimes of nuclear excited states by the delayed-coincidence method (methods of analysis).** Alikov, B.A.; Budzynski, M.; Ion-Mikhai, R.; Morozov, V.A. (Samarkand State University, Samarkand). *Sov. J. Particles Nucl. (Engl. Transl.);* 7: No. 2, 164-174(Apr 1976).

In this review we discuss the most frequently used method of analysis of delayed-coincidence spectra in study of the lifetimes of excited states of nuclei, and also versions of programs developed in the Division of Nuclear Spectroscopy and Radiochemistry of the Laboratory of Nuclear Problems at the Joint Institute for Nuclear Research.

NUCLEAR REACTIONS AND SCATTERING

33419 **Pre-equilibrium decay in nuclear reactions.** Seidel, K.; Seeliger, D.; Reif, R.; Toneev, V.D. (Technical University, Dresden, Germany). *Sov. J. Particles Nucl. (Engl. Transl.);* 7: No. 2, 192-214(Apr 1976).

Models of pre-equilibrium emission of particles from excited nuclei are discussed. The agreement of the predictions of these models with experiment is analyzed for various characteristics and reaction channels. Possible new applications of models of pre-equilibrium decay are noted. The relation of the pre-equilibrium approach to general methods of nuclear-reaction theory is discussed.

33420 **Separable representation method in problems of nuclear physics.** Zubarev, A.L. (Tashkent State University). *Sov. J. Particles Nucl. (Engl. Transl.);* 7: No. 2, 215-227(Apr 1976).

The application of the separable representation method in the two-body problem and in many-channel theory is reviewed. The results of numerical calculations are given, from which one can conclude that there is fairly rapid convergence. The connection between the method and variational principles is pointed out. The possibility of studying the corrections to the diffraction approximation is considered.

NUCLEAR MODELS

33421 **Kinematics of microscopic nuclear theory.** Vanagas, V.V. (Institute of Physics and Mathematics, Academy of Sciences of the Lithuanian SSR). *Sov. J. Particles Nucl. (Engl. Transl.);* 7: No. 2, 118-137(Apr 1976).

Microscopic nuclear theory is examined from the point of view of the general kinematic properties of the nuclear Hamiltonian and the special choice of spatial variables describing the collective and internal degrees of freedom of the nucleus.

RADIATION AND SHIELDING PHYSICS

REFER ALSO TO CITATION(S) 32098

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 33345

33422 (AD—A029946) **Collisional broadening of x-rays moving in solid targets.** Fortner, R.J.; Mathews, D.L.; Garcia, J.D.; Oona, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1976. Contract N00014-75-C-0499. 16p. NTIS (US Sales Only) $3.50.

In this paper high-resolution K x-ray spectra for boron (1 MeV) and neon (90 keV) projectiles moving in solid targets are reported. The x-ray transitions from the moving ions are found to be substantially broadened, compared to gas target spectral lines. Estimates of the extent of broadening are presented, and physical mechanisms responsible for it are discussed. (auth)

33423 (AD—A030016) **Calculated photon spectra and radiation dose from 50 MeV electrons stopping in air. Final report 1 Sep 75—30 Jun 76.** Lindgren, R.A. (Naval Research Lab., Washington, D.C. (USA)). Aug 1976. 21p. (NRL-MR—3335). NTIS (US Sales Only) $3.50.

The bremsstrahlung spectrum and dose resulting from discharging a beam of 50 MeV electrons into air has been determined. (auth)

33424 **Measurements of distributions of energy loss for 51, 102 and 153 keV protons in nine hydrocarbon gases.** Thorngate, J.H. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Instrum. Methods;* 137: No. 3, 569-576(15 Sep 1976).

The mean energies, second central moments (a measure of the width of the energy-loss distributions) and the third central moments (a measure of asymmetry) were calculated from energy-loss distributions measured for 51, 102 and 153 keV protons traversing methane, ethyne, ethene, ethane, propyne, propadiene, propene, cyclopropane and propane. For the second central moments, the best, but hardly satisfactory, agreement between measurement and theory was obtained when the classical scattering probability was used for the calculations; measured values exceeding calculated values by as much as 40%. Use of the first Born approximation gave values 20-50% below measured values. Measured third central moments exceeded theoretical values by 10-250%.

NEUTRON INTERACTIONS WITH MATTER

33425 (PNC-J—213-75-01) **Application of a neutron-gamma ray coupled cross section set to fast reactor systems.** Higashihara, Y.; Takemura, M.; Suzuki, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jul 1975. 54p. (In Japanese). TIC.

A neutron-gamma ray coupled cross section set, DLC-23D, produced at ORNL, has been applied to analyze fast reactor systems using one dimensional transport code ANISN. Comparison has been made with calculations based on a conventional removal-diffusion-build-up factor method to investigate the applicability of the design method. The set has also been applied in analyses to study the correlation with the capture gamma ray experiments using the JRR-4 facility for iron-water layers.

SOLID STATE PHYSICS

33426 Core overlap interactions in metals. Benedek, R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **15**: No. 6, 2902-2913(15 Mar 1977).

Short-range interatomic forces associated with the overlap of closed core shells in both simple and noble metals have been investigated by means of the Heitler-London approach. The required overlap integrals were evaluated numerically; core orbitals were represented by neutral-atom Hartree-Fock wave functions. The calculated overlap interactions were found to vary exponentially with separation, as expected. For most simple metals, the overlap interaction is small compared with the screened-Coulomb interaction, until separations considerably smaller than the nearest-neighbor spacing are reached. In noble metals, on the other hand, the overlap and screened-Coulomb potentials are comparable at the nearest-neighbor position. Some general features of overlap potentials are discussed. The construction of a composite interatomic potential by interpolation between low- and high-energy theories is investigated.

33427 One-orthogonalized-plane-wave calculation of Na KLV Auger line shapes. Feibelman, P.J.; McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., B;* **15**: No. 6, 3006-3013(15 Mar 1977).

In order to determine whether matrix-element effects might be responsible for the "mystery" peaks seen by Barrie and Street, 2.7 eV below threshold in the KL_1V and $KL_2/_3V$ Auger spectra of Na, we have calculated these spectra within a one-orthogonalized-plane-wave, independent-electron picture. We present here a description of the calculation as well as our results which indicate that matrix elements cannot explain these peaks.

33428 Time evolution of a quenched binary alloy. IV. Computer simulation of a three-dimensional model system. Sur, A.; Lebowitz, J.L.; Marro, J.; Kalos, M.H. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). *Phys. Rev., B;* **15**: No. 6, 3014-3026(15 Mar 1977).

We present results of computer simulations of the time evolution of a model binary alloy following quenching. Our model system is a simple-cubic lattice, each site of which is occupied by either an A or a B atom. There is a nearest-neighbor interaction which favors segregation into an A-rich and a B-rich phase at a point inside the two-phase region. Starting from a random configuration the system is quenched to and evolves at a finite temperature T as exchanges between atoms on nearest-neighbor sites are allowed to take place. In our present study, a lattice having a 20% concentration of A atoms (n-bar/sub A/ = 0.20), was quenched to temperatures T = 0.6T/sub c/ and T = 0.9T/sub c/, inside the two-phase region, and to T = 1.1T/sub c/. We study the evolution of the spherically averaged structure function S (k, t), the energy, and various cluster properties, and compare our results with relevant theoretical predictions. We also compare the late time cluster distributions of small clusters for T = 0.6T/sub c/ and T = 0.9T/sub c/ with the equilibrium cluster distributions for corresponding temperatures on the coexistence curve (namely, n-bar/sub A/ = 0.0146 at T = 0.6T/sub c/, and n-bar/sub A/ = 0.1272 at T = 0.9T/sub c/). This shows that the phase segregation at T = 0.6T/sub c/ takes place in two distinct stages (i) a "rapid" condensation of the A atoms into "liquid" drops and a "gas" phase consisting of monomers, dimers, etc., and (ii) a "slow" growth of the droplets. At T = 0.9T/sub c/ (which is well inside the "classical" metastable region) such a segregation still seems to take place but at a slower rate.

33429 Elementary excitations in disordered systems with short-range order. Kaplan, T.; Gray, L.J. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **15**: No. 6, 3260-3266(15 Mar 1977).

A general theory for elementary excitations in disordered systems with short-range order has been developed. The theory is based on an averaging formalism which is a generalization of an averaging technique introduced by Mookerjee. The theory is valid for excitations in all mean-free-path regions and can be used to generate analytic Green's functions which have the proper translational symmetry. The mathematical formalism is discussed for random alloys and amorphous solids. Illustrative calculations for Markov chains are shown to compare well with essentially exact numerical calculations.

SUPERCONDUCTIVITY

GENERAL THEORY

33430 Critical current of a superconductor. Mints, R.G.; Rakhmanov, A.L. (Institute of High Temperatures, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 193-194(Jun 1976).

The critical value of the transport current in a superconductor is found theoretically. A Nb-Zr alloy is used as an example. (AIP)

33431 Kinetic coefficients of superconductors with transition-metal impurities. Moskalenko, V.A.; Vladimir, M.I.; Digor, D.F. (Institute of Applied Physics, Academy of Sciences of the Moldavian SSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **2**: No. 9, 556-559(Sep 1976).

The principal results are presented of a calculation, within the framework of the Shiba-Rusinov model, of a series of kinetic coefficients in superconductors with magnetic impurities. It is shown that the contribution of the impurity band to these coefficients is most significant at low temperatures when $\sigma <$ or $= \gamma^2$ (σ is the pair destruction parameter, and γ is a parameter characterizing scattering from a magnetic impurity).

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 32824, 32825, 32826, 32827, 32828, 32829, 32830, 32831, 32844, 32855, 32857, 32858, 32859, 32860, 32861, 32862, 32863, 32880, 32973

33432 Self-field losses of superconducting multifilamentary composites. Fournet, G.; Mailfert, A. (LGEP-LCIE, Fontenay-aux-Roses, France). pp 449-450 of In Proceedings of the sixth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1976). From 6. ICED meeting; Grenoble, France (11 May 1976). See CONF-760508—.

The self field losses of superconducting multifilamentary composites are dependent on the critical current density of the superconducting filaments. An attempt is made to theoretically establish the self field losses expressions when the critical current density depends on the magnetic field applied to the wire. A twisted multifilamentary composite carrying a time-dependent transport current I(t) and simultaneously subjected to an orthogonal external induction B/sub e/(t) = KI(t) is considered. This situation stimulates the operation of a composite in a coil, the coefficient K depending on the point considered. The method consists first in calculating the self magnetic field profile in the wire, then determining the component of electric field due to the self magnetic field variation, and last calculating the losses, using the Poynting vector. The losses have been calculated for various experimental situations.

33433 Sound absorption in the intermediate-state thread structure of superconductors. Bruk, Y.M. (Institute of High-Pressure Physics, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **2**: No. 9, 552-556(Sep 1976).

The sound absorption associated with motion of the boundaries between the normal and superconducting states is calculated for arbitrary relative orientation of the wave vector, acoustic polarization vector, and magnetic field inducing the intermediate state of a superconductor. The thread structure of the intermediate state and long (relative to the spatial period of the structure and electron mean free path) wavelength sound waves are discussed. The absorption is related to the impedance of the intermediate state. The anisotropy of the absorption of longitudinal and transverse sound waves is considered.

33434 Propagation of normal zones in composite superconductors. Dresner, L. (Oak Ridge National Lab., Tenn. (USA)). *Cryogenics;* **16**: No. 11, 675-681(Nov 1976).

This paper describes calculations of propagation velocities of normal zones in composite superconductors. Full account is taken of (1) current sharing, (2) the variation with temperature of the thermal conductivity of the copper matrix, and the specific heats of the matrix and the superconductor, and (3) the variation with temperature of the steady-state heat transfer at a copper-helium interface in the nucleate-boiling, transition, and film-boiling ranges. The theory, which contains no adjustable parameters, is compared with experiments on bare (uninsulated) conductors. Agreement is not good. It is concluded that the effects of transient heat transfer may need to be included in the theory to improve agreement with experiment.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

33435 (SAND—76-0620) **Simulation of inertial inputs to a strapdown platform for inertial great circle trajectories.** Perdreauville, F.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract E(29-1)-789. 28p. Dep. NTIS $4.00.

Equations are developed for computing inertial accelerations and angular rates that would be measured by the accelerometers and gyroscopes in a strapdown inertial platform. The accelerations and angular rates are computed for a body that is moving in an inertial great circle trajectory. A Fortran computer code which implements the calculations is listed. 4 figures.

33436 The theory of one-dimensional Schroedinger operators with a periodic potential. Meiman, N.N. (Formerly member of the Institute for Theoretical and Experimental Physics). *J. Math. Phys. (N.Y.);* **18**: No. 4, 834-848(Apr 1977).

We carry out the spectral analysis of the n-band Hill equation by examining the external problem for a class of entire functions with least derivation from zero. The spectrum is characterized in terms of hyperellyptic integrals and the geometry of admissible points (band edges).

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 33375, 33395, 33401

STATISTICAL PHYSICS AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 32171

33437 Renormalization group structure for translationally invariant ferromagnets. Baker, G.A. Jr.; Krinsky, S. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Math. Phys. (N.Y.);* **18**: No. 4, 590-607(Apr 1977).

We introduce a correlation function description of the renormalization group approach to critical phenomena. Our work is based on treating the renormalization group operator as a linear mapping on the set of Ursell functions, rather than as a nonlinear mapping on the space of Hamiltonians. We mainly consider the "mean-spin" renormalization group, but the closely related "decimation" transformation is also considered. Using this approach, we demonstrate for a suitable class of system that the spectrum of the renormalization group operator is bounded and countably infinitely degenerate. We give counterexamples to the notion that there must be convergence to a renormalization group fixed point. Our formulation of the renormalization group is sufficiently general so that convergence to a fixed point does not necessarily imply hyperscaling, i.e., the vanishing of the anomalous dimension of the vacuum, ω^*. In the case of convergence to a fixed point we find $\delta = (d+\sigma-\omega^*)/(d-\sigma-\omega^*)$, with $\omega^* <$ or $=0$ necessarily. Above the critical temperature we are able to prove that convergence is obtained to the "infinite temperature fixed point," which result generalizes the central limit theorem to ferromagnetically correlated variables.

33438 Crystal nucleation in a three-dimensional Lennard-Jones system. II. Nucleation kinetics for 256 and 500 particles. Mandell, M.J.; McTague, J.P.; Rahman, A. (Department of Chemistry, University of California, Los Angeles, California 90024). *J. Chem. Phys.;* **66**: No. 7, 3070-3075(1 Apr 1977).

We have, by molecular dynamics computer simulation, observed homogeneous, spontaneous crystal nucleation in the 256-particle Lennard-Jones fluid at rho*=0.91, 0.92, and 0.93, and in the 500-particle fluid at rho*=0.92, 0.93, and 0.94. For the 500-particle system a nuclear region may be identified, and the nucleation and growth processes are found to be temporally separate. In all these events the nucleated phase was a body-centered (nearly cubic) structure. We believe this to be a manifestation of the Ostwald step rule.

ELECTRICITY AND MAGNETISM

REFER ALSO TO CITATION(S) 33437

MAGNETIC FUSION ENERGY

33439 World survey of major facilities in controlled fusion research. *Nucl. Fusion;* **Special suppl.**: 866(1976).

This is a third, updated and revised, edition of the "World Survey of Major Facilities in Controlled Nuclear Fusion Research", published as a special supplement to Nuclear Fusion. The purpose of this survey is to provide a broad and current outline of the research in controlled thermonuclear fusion. The scope of this third edition has been expanded to include fusion reactor design groups, fusion data centres, and more information on laser- and electron-beam fusion programmes. Only information received officially from contributing countries in response to a questionnaire has been considered for publication. All contributions have been brought up to date, the information being as correct as possible up to June 1976. The Personnel Index, a new feature of this supplement, lists about 3500 names of researchers and is intended as a "Who's Who" in nuclear fusion.

PLASMA RESEARCH

33440 Low-frequency electric microfield distributions in a plasma containing multiply-charged ions: Extended calculations. Tighe, R.J.; Hooper, C.F. Jr. (Physics Department, University of Florida, Gainesville, Florida 32611). *Phys. Rev., A;* **15**: No. 4, 1773-1779(Apr 1977).

The formalism needed for the computation of electric microfield distributions in plasmas is extended as follows: (i) The perturbing ions and electrons in the plasma are allowed to have different kinetic temperatures; (ii) two species of perturbing ions, of charge Z_1 and Z_2, may be present in any given proportion. Computed results are presented graphically for parameter ranges which are of interest in the study of laser-produced plasmas.

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 33366, 33540, 33542

33441 (EUR-CEA-FC—822) **Radiation losses from oxygen and iron impurities in a high temperature plasma.** Breton, C.; de Michelis, C.; Mattioli, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jun 1976. 43p. NTIS (US Sales Only).

Radiation and ionization losses due to impurities present in a high temperature plasma have been calculated for a light element (oxygen), which is completely stripped in the core of existing Tokamak discharges, and a heavy one (iron), which is only partially stripped. Two extreme cases have been treated: in the first one coronal equilibrium is reached; the radiated power is then equal to the product of the electron density, the impurity density, and a function of the electron temperature; in the second one impurities recycle with a constant radial velocity v_0 in a background plasma; radiation and ionization losses are proportional to the impurity flux and are a decreasing function of the diffusion velocity. The results presented can be used to evaluate losses in a practical case.

33442 (IPPJ—234) **Travelling wave multiple mirror field for confinement of high temperature plasmas.** Aihara, Shuko. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1975. 18p. NTIS (US Sales Only).

Travelling wave multiple mirror confinement of high temperature plasma for fusion application was examined by theoretical discussion using a diffusion equation. It was shown that confinement time and plasma density in the travelling wave multiple mirror field were several hundreds times longer and higher than those in the static multiple mirror field.

33443 Enhanced penetration of neutral-beam-injected ions by vertically asymmetric toroidal-field ripple. Jassby, D.L.; Goldston, R.J. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 4, 613-622(1976).

The penetration length of energetic neutral-atom beams injected into a tokamak plasma can be effectively increased by a large factor if the beams are injected vertically from the bottom and the toroidal magnetic field has significant ripple below the midplane. The energetic ions resulting from ionization of the fast neutrals are ripple-trapped and drift upward to the midplane region. The ripple

must decrease substantially in the region above the midplane, so that the ions can be captured and retained in the central plasma region during their entire slowing-down period. Orbit calculations with a Monte-Carlo guiding-centre code demonstrate the feasibility of this trapping process. 110- to 150-keV deuterons can be deposited near the centre of plasmas with <nsub(e)<aZsub(eff) approximately 10^{17} cm^{-2}, when the ripple near the magnetic axis and in the region below is of the order 1%.

33444 Electromagnetic-wave relaxation length in rf heating in tokamaks. Rubenchik, A.M. (Institute of Automation and Electrometry, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 6, 204-206(Jun 1976).

Assuming an isothermal plasma whose density varies gradually, it is shown that the relaxation length of electromagnetic waves can be extremely short due to the excitation of plasma waves. (AIP)

33445 Structure of ionizing MHD shock wave in plasma. Zakaidakov, V.V.; Synakh, V.S. (Computation Center, Siberian Branch, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 300-302(Jul 1976).

The structure of an ionizing MHD shock wave in a dense plasma is studied. Calculations are carried out for argon initially at p=100 torr and T=300degreeK and for a magnetic field of H=20 kG. The basic porperties vary in a nonmonotonic manner behind the shock front. The magnetic field increases the plasma heating. To illustrate the sensitivity of the solution to the shock-wave velocity U, H, and p, the results of similar calculations are reported for the following cases: 1) U=5 km/sec, p=100 torr, H=20 kG; 2) 10 km/sec, 100 torr, 100 kG; 3) 10 km/sec, 200 torr, 10 kG.

33446 Thermonuclear confinement system with twin mirror systems. Dimov, G.I.; Zakaidakov, V.V.; Kishinevskii, M.E. (Institute of Nuclear Physics, Siberian Branch, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 326-333(Jul 1976).

An open confinement system for thermonuclear reactors in porposed. Ions with energies of approximately 1 MeV are continuously introduced into the system by atomic-beam injection. (AIP). results are in good qualitative agreement.

33447 Equilibrium of finite-β plasma in open confinement system. Kukushkin, A.S. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 334-337(Jul 1976).

In an analysis of the equilibrium of a collisionless plasma in an axisymmetric confinement system, the ion profile in the median plane of the system is assumed to be given and to be of such a nature that the plasma configuration turns out to be short in comparison with the scale length of the magnetic field. In this case, and with β much less than 1 (but finite), the approximation of straight magnetic lines of force an exact analytic solution. The similarity parameter $\beta(L/R_0)^2$ is found for equilibrium configurations; here R_0 is the plasma radius and L is the scale length of the magnetic field. Numerical calculations show that a magnetic well forms in the case β $(L/R_0)^2 0.5$ in a simple confinement system containing a plasma. The stability of the resulting equilibrium configurations is not analyzed. It is suggested that stability can be achieved, e.g., with the help of a feedback system.

33448 Local suppression and intensification of rf turbulence in current-carrying plasma. Longinov, A.V.; Perepelkin, N.F.; Suprunenko, V.A. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 344-349(Jul 1976).

An experimental study has been made of the rf turbulence of hot electron and hot ion plasmas in the Uragan stellarator with a frequency spectrum at $\omega \sim \omega/\text{sub}\ \pi/$ and $2\omega/\text{sub}\ \pi/$. The results clearly imply that the slow branch of a fast magnetosonic wave is excited in the plasma near the lower hybrid resonance when two different heating methods are used (ohmic heating and ion cyclotron heating). The intensification of the noise above the thermal level could correspondingly result from the excitation of small-scale steady-state acoustic turbulence: ion sound of the electron sound. It is suggested on the basis of a comparative analysis of the turbulence characteristics that there may be local turbulence in various regions of a current-carrying, hot electron plasma. The sporadic (explosive) nature of the noise generation may be related to a buildup effect.

33449 Stochastic plasma heating by rf fields. Akhiezer, A.I.; Bakai, A.S. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 359-361(Jul 1976).

A study is made of the possibility of plasma heating by regular rf fields concentrated near the plasma boundary or in thin layers within the plasma. The proposed heating method is based on Fermi stochastic acceleration. Under certain conditions the average particle energy increases in proportion to the square of the time, and a steady-state step-function particle velocity distribution is established in a comparatively short time.

33450 Interaction of a modulated microwave signal with a plasma. Nanobashvili, S.I.; Rostomashvili, G.I.; Tsintsadze, N.L. (Institute of Physics, Academy of Sciences of the Georgian SSR, Tbilisi). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **2**: No. 7, 236(Jul 1976).

33451 MHD simulation of a beat frequency heated plasma. Milroy, R.D.; Capjack, C.E.; James, C.R.; McMullin, J.N. (Alberta Univ., Edmonton (Canada). Dept. of Electrical Engineering). *Can. J. Phys.;* **54**: No. 21, 2140-2146(1 Nov 1976).

8 refs.

The heating of a plasma in a solenoid, with a beat frequency harmonic which is excited at a frequency near to that of a Langmuir mode in a plasma, is examined. It is shown that at high temperatures the heating rate is very insensitive to changes in plasma density. The amount of energy that can be coupled to a plasma in a solenoid with this heating scheme is investigated by using a one-dimensional computer code which incorporates an exact solution of the relevant MHD equations. The absorption of energy from a high powered laser is shown to be significantly enhanced with this process.

33452 Lower hybrid heating of an electron-cyclotron-resonance plasma in a canted magnetic mirror. Friedrich, W.A.; Shohet, J.L. (Univ. of Wisconsin, Madison). *IEEE Trans. Plasma Sci.;* **PS-4**: No. 4, 296-297(Dec 1976).

Plasma heating at the lower hybrid resonance was studied experimentally in a canted magnetic mirror in order to determine the effects of magnetic field curvature on heating efficiency. Heating occurred mainly on what would be the "outside" of an equivalent torus, peaking near the hybrid resonant layer. The best conditions for heating were seen to be a relatively flat density profile of magnitude slightly below that where hybrid resonance would be expected. The density profile was seen to move "outward" as cant angle was increased, while the hybrid layers were seen to move oppositely, toward what would be the inside of the torus. No significant deleterious effects on the efficiency of the lower hybrid resonant heating (LHRH) were observed as the canting was changed.

33453 Rapid thermal transport from turbulent skin layer to plasma core in a toroidal experiment. Nishida, Y.; Hirose, A.; Skarsgard, H.M. (Department of Physics, University of Saskatchewan, Saskatoon, Canada, S7N OWO). *Phys. Rev. Lett.;* **38**: No. 12, 653-656(21 Mar 1977).

Anomalously rapid thermal transport from a skin layer to the plasma core has been observed in a toroidal turbulent heating experiment. The thermal transport rate is approximately two orders of magnitude faster than the classical rate based on the anomalous electron collision frequency.

33454 Dynamical model for magnetic signal interpretation in relativistic-electron-beam: heated plasmas. Chu, K.R.; Clark, R.W. (Institute of Physics, National Tsing Hua University, Hsinchu, Taiwan, Republic of China). *Phys. Rev. Lett.;* **38**: No. 13, 704-707(28 Mar 1977).

A dynamical model is developed to infer the energy content of a relativistic-electron-beam—heated plasma column from global or local magnetic field measurements. Under this model, magnetic signals are interpreted in terms of the propagation of macroscopic magnetosonic waves, and differences in charcteristics such as beam duration, probe position, and pulse shape, etc., can be distinguished. This model applied to experimental regimes where the commonly used static model becomes invalid.

33455 Poloidal profiles and transport during turbulent heating. Mascheroni, P.L. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 4, 634-645(Apr 1977).

The current penetration stage of a turbulently heated tokamak is modeled. The basic formulae are written in slab geometry since the dominant anomalous transport has a characteristic frequency much larger than the bounce frequency. Thus, the basic framework is provided by the Maxwell and fluid equations, with classical and anomalous transport. Quasi-neutrality is used. It is shown that the anomalous collision frequency dominates the anomalous viscosity and thermal conductivity, and that the convective wave transport can be neglected. For these numerical estimates, the leading term in the quasi-linear series is used. During the current penetration stage the distribution function for the particles will depart from a single Maxwellian type. Hence, the first objective was to numerically compare calculated poloidal magnetic field profiles with measured, published poloidal profiles. The poloidal magnetic field has been calculated using a code which handles the anomalous collision frequency self-consistently. The agreement is good, and it is concluded that the current penetration stage can be satisfactorily described by this model.

33456 Plasma density in an electrostatically plugged spindle cusp. Hayward, R.L.; Dolan, T.J. (University of Missouri-Rolla, Rolla, Missouri 65401). *Phys. Fluids;* **20**: No. 4, 646-648(Apr 1977).

The theoretical plasma density and confinement time for an electrostatically plugged spindle cusp experiment (R=0.16 m, B/sub r/=0.3 T, B/sub z/=0.5 T) are compared with experimental data. The plasma is produced by injection of a 5 mA, 1 keV electron beam into H_2 at 10^{-5} Torr. The electron density and confinement time, measured with a 20 GHz interferometer, are on the order of 2×10^{16} m^{-3} and 50 μsec.

33457 Finite-Larmor-radius stabilization in a sharp-boundary Vlasov-fluid screw pinch. Turner, L. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 4, 654-661(Apr 1977).

Starting from the basic equations of the Vlasov-fluid model, assuming small ion Larmor radii, and assuming unstable, long-wavelength perturbations in a sharp-boundary screw pinch whose equilibrium distribution of ion velocities is isotropic, a derivation is presented of the dependence upon ζ/sub perpendicular/(r) and its derivatives of the dominant terms in perturbations of the ion distribution, the ion number density, the ion fluid velocity, the pressure tensor, and the heat flux vector. A differential equation governing ζ/sub perpendicular/(r) is derived and solved. A dispersion relation for a perturbation with arbitrary azimuthal mode number is derived by application of boundary conditions appropriate for a sharp-boundary screw pinch. It is found that ideal magnetohydrodynamics and the Vlasov-fluid model yield identical dispersion relations only for an m=1 mode. For m< or =2, the Vlasov-fluid model yields a damping of the ideal magnetohydrodynamic growth rate with increasing ion temperature. The m=2 instability is extinguished at an ion temperature equal to one-fourth of that given by Freidberg's analysis. This result allows greater leeway for wall stabilization of m=1 modes while maintaining finite-Larmor-radius stabilization of m=2 modes in theta-pinch machines, such as scyllac.

33458 Vlasov-fluid theory of short-wavelength instabilities of a sharp-boundary screw pinch. Turner, L. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 4, 662-674(Apr 1977).

The physics of instabilities of a sharp-boundary screw pinch is analyzed using the Vlasov-fluid model of Freidberg. An ordering especially applicable to the study of stabilized Z pinches is used. The equations of the Vlasov-fluid screw pinch differ from those of an ideal magnetohydrodynamic screw pinch in two crucial respects: a frequency-dependent compressibility function γ/sub M/(ω) and a magnetoviscosity term that can induce finite-Larmor-radius stabilization. The domain of marginal stability of the Vlasov-fluid screw pinch is identical to that of the ideal magnetohydrodynamic screw pinch, in agreement with the results of Freidberg. Even when finite-Larmor-radius effects are ignored, the ratio (Vlasov-fluid growth rate)/(ideal magnetohydrodynamic growth rate) is less than unity in all cases studied. When β is finite, this ratio must approach zero as marginal stability is approached. In addition, for unstable modes with m<1, finite-Larmor-radius stabilization effects in the Vlasov-fluid model can be significant when βvertical-barω/kv/sub th/vertical-barvery-much-greater-than 1 and vertical-barω/kv/sub th/vertical-barvery-much-less-than 1, where v/sub th/ is the ion thermal speed and k is the wavenumber. In contrast, these effects are always insignificant in a magnetohydrodynamic model even when a phenomenological magnetoviscosity term is included! Numerical results are presented for m=1 and m=2 instabilities of a stabilized Z pinch. This analysis may help to explain the apparent stability of the Kurchatov reversed-field experiment.

33459 Limitation of pressure of tokamak plasmas. Yoshikawa, S. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 4, 706(Apr 1977).

With the previously obtained equilibrium solution for arbitrary plasma pressure distribution in toroidal geometry, it is shown that the plasma pressure is limited within the assumption of large aspect ratio expansion.

33460 Numerical study of theta-pinch implosion including two-step ionization. Hui, B.H.; Davidson, R.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **20**: No. 4, 707-708(Apr 1977).

For parameters appropriate for high-density theta-pinch implosions it is shown that two-step ionization processes can lead to a large enhancement in the effective ionization rate and thereby play in important role in the implosion dynamics.

33461 Spectroscopic observations of internal disruptions and m=1 oscillations in Doublet IIA. Brooks, N.H. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **20**: No. 4, 711-712(Apr 1977).

Sawtooth-like oscillations in the line emission of impurity ions have been observed on Doublet IIA which agree in phase and frequency with fluctuations in the soft x-ray signal caused by internal disruptions.

33462 Energy distribution of fast test particles slowing down in plasmas. I. Time-independent energy spectra in infinite medium. Husseiny, A.A.; Sabri, Z.A.; Harris, D.R. (Nuclear Science and Engineering Division, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., A;* **15**: No. 4, 1659-1667(Apr 1977).

A model is developed to describe the scattering of fast test particles in an infinite background plasma in which conditions are such that the probability of elastic scattering by plasma ions much exceeds the probability of elastic scattering by plasma electrons. Encounters leading to large angles of scattering are excluded in calculating the scattering kernel and the slowing-down density. These functions are evaluated using the quantum-mechanical elastic scattering cross sections. The encounter density is obtained by solving the space- and time-independent Boltzmann equation in the presence and in the absence of fusion reactions between the test particles and the plasma ions. Asymptotic energy distributions in the slowing-down range below the source energy are obtained for both cases. The average density and mean energy of the test particles in the slowing-down range are also evaluated. The results are found for arbitrary sources of test particles, taking into account spread in the initial energy of the particles. Binary and multicomponent plasmas are considered.

33463 Energy distribution of fast test particles slowing down in plasmas. II. Time-dependent energy spectra in finite media. Husseiny, A.A.; Sabri, Z.A.; Harris, D.R. (Nuclear Science and Engineering Division, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., A;* **15**: No. 4, 1668-1679(Apr 1977).

The time-energy spectrum of fast particles released in background plasmas is evaluated for the cases of monoenergetic impulses and sources dispersed in time and energy, as well as for general source spectra. Distant encounters are assumed to contribute mainly to the energy degradation of the test particles in the slowing-down range in which ions are treated as fixed centers, and in which the probability of elastic scattering by electrons is insignificant compared to the probability of scattering by plasma ions. The results give a slowing-down time close to that evaluated by approaches that account for close encounters. Asymptotic solutions of the Boltzmann equation are also obtained, and the effects of the confinement time of the test particles on the time-energy spectrum are taken into account. Confinement times characteristic of open-ended devices, tokamaks, and Bohm-like plasmas are considered. Pitch-angle scattering is not considered here, and hence only a rough estimate of the parameters relevant to neoclassical processes is given. The average density and mean energy of the test particles are obtained in the slowing-down range for these three types of plasmas. Discrepancies resulting from the classical treatment of scattering as opposed to the quantum-mechanical treatment are pointed out. A multienergy approach is introduced for numerical calculations; such an approach is necessary in particular for model dependent studies. The approach is rather flexible and can accommodate different types of spatial dependence and scattering processes.

33464 Magnetic surfaces in a dc toroidal octupole field under the influence of magnetic field perturbations. Rudmin, J.W.; Meade, D.M. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *J. Appl. Phys.;* **48**: No. 4, 1697-1700(Apr 1977).

Calculations are presented which show the effects of magnetic field perturbations on toroidal multipole fields used for plasma confinement. The field topology was destroyed, with the attendant formation of magnetic surfaces. In contrast to earlier calculations, exact equations are solved numerically and the results apply to actual experiments in which the plasma lifetime was seriously decreased by the perturbing field.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 33530

33465 (IPPCZ—206, pp 47-49) **Microwave diagnostics of a strong are discharge plasma in SF_6.** Musil, J.; Zacek, F. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). Jun 1975.

From 8. Czechoslovak seminar on plasma physics and technology; Zvikov, Czechoslovakia (28 Apr 1975).

In VIII Czechoslovak seminar on plasma physics and technology.

The theory of electromagnetic wave propagation in a highly collisional plasma ($\nu/\omega << 1$) is summarized. In contrast to the weakly collisional plasma case, the phase shift of the transmitted wave depends neither on the plasma density, nor on the collision frequency ν. Thus, the only information about the plasma can be obtained from the transmitted power ratio. The free-space method can be used even for densities higher than the critical plasma density. The theoretical results are applied to microwave measurements of the plasma density of a strong arc discharge in SF_6 at high pressures.

33466 Shortwave plasma diagnostics. Vainshtein, L.A.; Birger, E.S.; Konyukhova, N.B.; Kosarev, E.L.; Prudkovskii, G.P. (Institute

of Physical Problems, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 362-369(Jul 1976).

An asymptotic (shortwave) solution is derived for the problem of the propagation of wave beam through an inhomogeneous plasma whose dielectric constant ϵ is a function of the cylindrical coordinate r only. Refraction, diffraction, and attenuation of the wave beam are taken into account in this solution. The results can be used to solve the direct problem: that of calculating the transmission coefficient (between the transmitting antenna and the receiving antenna) through a plasma with a known profile ϵ (r) and to determine the instrumental function of the diagnostic apparatus. It is shown that the solution of the inverse problem reduces to the successive solution of two linear integral equations of the first kind: a convolution equation and an Abel equation.

33467 Theory of electrostatic probes in a low-density flowing continuum plasma: numerical solutions for a sphere stagnation point. Kodera, K.; Chang, J.S. (Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France)). *J. Phys., D (London);* **9**: No. 16, 2349-2358(11 Nov 1976).

An exact numerical method has been used to study a probe stagnation point in a continuum flowing plasma. The solutions for the 'low-density continuum' plasma, i.e. with mean free path much less than probe radius much less than Debye length, are calculated for Reynolds numbers Re from 0 to 400, charged diffusion Reynolds numbers Rasub(c) from 0 to 10, and scaled probe potentials phisub(p)/epsilon from 0 to +- 32, where phisub(p) = eVsub(p)/kTe, epsilon = T/Te. The numerical results show that (i) the usual semi-log method for temperature determination leads to large errors; (ii) the effect of flow leads to large errors in the space potential determination; (iii) for a sufficiently large accelerating potential, the currents always show a linear dependence; (iv) approximate current expressions are suggested at smaller Reynolds numbers (Re much less than 0.1) and diffusion Reynolds numbers (Rasub(c) less than or equal to 1).

33468 High energy ion analyzer for laser-produced plasma studies. Decoste, R.; Ripin, B.H. (University of Maryland, College Park, Maryland 20740). *Rev. Sci. Instrum.;* **48**: No. 3, 232-236(Mar 1977).

A simple electrostatic-deflection multichannel time-of-flight ion analyzer optimized to study high energy ion species from laser-produced plasmas is described. For this application moderate species and energy resolution over a wide dynamic energy range is desirable. The analyzer was designed to achieve a dynamic energy range from 1 to 1000 keV with a 15 kV power supply. Design considerations are presented together with some typical experimental results.

33469 Measurements of 400-MW/cm² proton fluxes. Eichenberger, C.; Humphries, S. Jr.; Maenchen, J.; Sudan, R.N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *J. Appl. Phys.;* **48**: No. 4, 1449-1455(Apr 1977).

Proton current densities in excess of 1 kA/cm² have been measured at the cathode in the center of a pinched-electron-beam diode. Efficiencies (I/sub i//I) of about 10% have been achieved to obtain in excess of 12 kA of ions. A surface breakdown plasma on the anode allows attainment of the pinched-beam equilibrium early in the voltage pulse. The peaking of the ion current density near the pinch roughly follows the theoretical predictions. Measurements were made with biased charge collectors. The theory of these probes has been reconsidered for the high-current-density limit, and it is shown that the probe response gives the actual ion current density independent of secondary emission processes on the collector.

33470 Zone-plate coded imaging on a microscopic scale. Ceglio, N.M. (Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **48**: No. 4, 1563-1565(Apr 1977).

An experimental demonstration of the applicability of zone-plate coded imaging (ZPCI) techniques on a microscopic scale has been completed. The electron emission from microscopic test-pattern sources was imaged. Optically reconstructed images were compared with numerically calculated image distributions and the agreement was good. These experiments verified the theoretical resolution limit on a scale less than 10 μm, while also demonstrating the applicability of ZPCI to charged-particle imaging. This coded imaging technique appears well suited to high-resolution imaging of short-wavelength radiations (x rays and charged particles) from laboratory plasmas of limited size.

33471 Zone-plate coded imaging of laser-produced plasmas. Ceglio, N.M.; Attwood, D.T.; George, E.V. (Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **48**: No. 4, 1566-1569(Apr 1977).

The first successful demonstration of high-resolution tomographic imaging of a laboratory plasma using a coded imaging technique is reported. Zone-plate coded imaging has been used to image the x-ray emission from laser-compressed D-T-filled microballoon targets. The zone-plate camera exhibited a planar resolution ~8 μm and had a tomographic resolution of ~74 μm. This allowed three-dimensional viewing of the target emission from a single shot in planar slices.

33472 Theory of a spherical electrostatic probe in a continuum plasma: Analytical models. Brailsford, A.D. (Research Staff, Ford Motor Company, Dearborn, Michigan 48151). *J. Appl. Phys.;* **48**: No. 4, 1753-1755(Apr 1977).

A simple physical model of the charge distribution surrounding a biased spherical probe in a quiescent plasma, suggested by the theory of Su and Lam, is used to rederive the probe current-voltage characteristic. The result is compared with that of a slightly different version due to Kiel and with the exact numerical results of Baum and Chapkis. It is shown that if the ratio of the probe radius to the Debye length of the plasma is greater than or of the order of unity, the model calculation is in excellent agreement with the exact results when the dimensionless probe voltage phi/sup asterisk//sub p/ ,=vertical-barephi/sub p//kTvertical-bar in standard notation, is greater than 10, for both thick and thin sheaths. The comparison also provides an assessment of the importance of various additional validity criteria encountered in analytical treatments of the problem.

PLASMA KINETICS - GENERAL

REFER ALSO TO CITATION(S) 33357, 33358, 33449

33473 (IPPJ—237) Stable production of intense electron beam plasma with ion back stream. Uramoto, J. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1975. 40p. NTIS (US Sales Only).

An intense electron beam is extracted without space charge limit from a dc plasma source along a magnetic field. The beam space charge is neutralized stably through back streaming of self-ionized ions from the beam extracting anode region where a neutral gas is fed locally. In Appendix I, a space charge free electron gun is designed under this neutralization method. In Appendix II, a dynamic discharge through a series resistance is described, where an operative mechanism of the well-known TP-D plasma is clarified.

33474 (IPPJ-DT—47) Apparatus for plasma experiment in the region of the supercritical point of mercury. Fujiwaka, S.; Ikezi, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Feb 1975. 35p. (In Japanese). NTIS (US Sales Only).

An apparatus to study the change of electron state around the critical point of mercury was constructed. The critical point of mercury is at T asymptotically equals 1600°K and P asymptotically equals 1600 atmosphere. A pressure vessel is required for the experiment. A capsule which contained mercury was set in a pressure vessel filled with compressed argon gas. The capsule was heated with a heater, and the required temperature was obtained. Optical measurement was made through sapphire windows. Detail of construction is described in this paper. A compressor used to compress the argon gas was a three stage compressor of air-oil-gas made by HASKEL Co., in U.S.A. It consisted of a hydraulic pump, a gas booster and an intensifier. Estimation of strength according to the Japanese law is required. Relief valves were equipped for safety. Strength estimation of pipings is also required. A barrier wall was made for protection in case of emergency. The pressure vessel was made of Be-Cu alloy, which has good cooling characteristics. Safety investigation of the vessel is described. A water jacket was provided outside of the vessel for cooling, and sapphire windows were supported by BeA-25 (Be-Cu) plugs. The mercury was contained in a N6 capsule sealed by sapphire rods. Various regulations by law were required.

33475 Surface curvature effect on MHD forced convection with transverse magnetic field. Bodas, N.G. (Madhav Inst. of Tech. and Science, Gwalior (India)). *Indian J. Technol.;* **14**: No. 5, 222-224(May 1976).

7 refs.

The singular perturbation method has been used to formulate the second order boundary layer equations for two-dimensional forced convection of an electrically conducting, incompressible and viscous fluid from a curved surface with an imposed transverse magnetic field. These equations take into account the surface curvature effect, which is analysed. Similarity solutions have been obtained. The equations have been solved numerically on a computer. It is observed that a convex surface curvature reduces the heat transfer at the wall.

33476 Numerical simulation of the influence of an rf field on a plasma with Coulomb collisions. Ivanov, M.F. (L. D. Landau Institute of Theoretical Physics, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 350-352(Jul 1976).

In a one-dimensional simulation of a plasma by the method of "weighted particles," Coulomb collisions are taken into account in the BGK approximation. This new calculation procedure is used to solve the problem of the behavior of a plasma in an rf electric field. A comparison is made of the results obtained with Coulomb collisions neglected, with electron-electron collisions incorporated, and with electron-electron and electron-ion collisions incorporated.

33477 Relaxation times for establishing quasi-stationary state populations in non-thermal plasmas. Cacciatore, M.; Capitelli, M. (Bari Univ. (Italy)); Drawin, H.W. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *Physica, B, C;* **84**: No. 2, 267-274(Sep 1976).

The temporal relaxation of excited state populations towards a quasi-stationary state has been calculated by solving the corresponding time-dependent rate equations. The relaxation times which follow from these calculations give values which differ for the higher excited levels up to one order of magnitude from existing literature values. The calculation of relaxation times is re-examined on the basis of time-dependent coupling between all excited states. A new formula for the relaxation times is obtained in which intervene the initial conditions and the collisional-radiative interaction frequencies between all levels. It gives numerical results in agreement with the time-dependent solutions of the coupled system of rate equations.

PLASMA KINETICS - EXPERIMENTAL

33478 Formation of fast-electron cloud during injection of intense relativistic electron beam into vacuum. Ryutov, D.D.; Stupakov, G.V. (Institute of Nuclear Physics, Siberian Branch, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 309-315(Jul 1976).

An analytic dynamic description is given for the formation of the relativistic-electron cloud which appears near the anode foil of a high-current electron accelerator. Under certain conditions the density of this cloud can exceed the density of the initial relativisitic beam by 2-3 orders of magnitude.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 33366

33479 (EUR-CEA-FC—826) **Nonlinear evolution equations having a physical meaning.** Nakach, R. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jun 1976. 22p. (In French). NTIS (US Sales Only).

The nonstationary self-similar solutions of the nonlinear evolution equations which can be solved by the inverse scattering method are studied. It turns out, as shown by means of several examples, that when the L linear operator associated with these equations, is of second order and only then, the self-similar solutions can be expressed in terms of the various Painleve's transcendents.

33480 (IPPJ—238) **Study of helical plasma equilibria.** Hamada, Y.; Suzuki, Y.; Ohasa, K.; Fujiwara, M.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1975. 18p. INIS.

The equilibrium of the plasma limited by the material limiter or the separatrix in the linear stellarator system was solved numerically by the finite difference method. The expansion and the deformation of the plasma column due to the longitudinal plasma current and the plasma pressure were obtained and were in agreement with the predicted values in the simple case where the analytical solutions were already found.

33481 (JAERI-M—6292) **Kinetics model for the horizontal displacement of a toroidal plasma column.** Kambayashi, Y.; Hara, M. (Japan Atomic Energy Research Inst., Tokyo). Nov 1975. 45p. (In Japanese). INIS.

A kinetics model is presented which simulates the horizontal displacement of a toroidal plasma column in systems of the Tokamak type. Applications of the model are given with the obtained results, such as a numerical code "FLIC" which calculates the frequency characteristics and an analogue simulator which analyzes the time response.

33482 (JAERI-M—6305) **Binary collision model for plasma simulation with a particle code.** Takizuka, T. (Japan Atomic Energy Research Inst., Tokyo). Nov 1975. 24p. (In Japanese). NTIS (US Sales Only).

A binary collision model by the Monte Carlo method is proposed for plasma simulation with a particle code. The model describes a collision integral of the Landau form. Collisional effects in a plasma independent of the space are simulated, the results indicate validity of the model.

33483 (JINR-R—11-8245) **Mathematical simulation adequacy of complex systems by simplified ones (Macroparticle method).** Makhan'kov, V.G.; Pollyak, Yu.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 17p. (In Russian). INIS.

13 refs.; submitted to the journal Sov. Phys. - Tech. Phys.

Using numerical modelling (by the enlarged-particles method) of processes occurring in plasma and in electron beams, the possibility of obtaining the criteria of adequacy of such models to the initial physical systems is studied. General approaches to the modelling accuracy control are considered.

33484 Numerical study of the MHD spectrum in tokamaks with a non-circular cross-section. Kerner, W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 4, 643-650(1976).

The behaviour of a class of exact tokamak equilibria is investigated in the context of ideal magnetohydrodynamics. The equilibrium solution allows for a general plasma cross-section shape, restricted to systems with essentially flat toroidal current profiles. The spectrum of the eigenmodes is evaluated by extremizing the Lagrangian using a Galerkin procedure. The different branches of the spectrum are appropriately represented by expanding the displacement vector in terms of the eigenfunctions of the corresponding straight limit. The perturbed vacuum field is expressed by a vector potential. The code is applied to various configurations with a fixed and with a free plasma boundary. The influence of ellipticity of the cross-section and of the aspect ratio on the spectrum is discussed.

33485 Cyclotron emission from a plasma of arbitrary density. Audenaerde, K.R. Utrehct; Rijksuniversiteit (1976). 116p.

Thesis.

In this thesis, the optical constants of a non-relativistic homogeneous plasma of arbitrary density are calculated at the harmonics of the electron cyclotron frequency. First the correlation matrix of the current density fluctuations whithin the plasma is derived from the Klimontovitch equation, and then this result is used to find the spectra emissivity. The calculation of the spectral absorptivity starts from the Vlasov equation. It is verified that emissivity and absorptivity satisfy Kirchhoff's law in the case of a Maxwellian electron distribution. In two special cases, i.e. for a tenuous plasma and for emission perpendicular to the static magnetic field, the results can be expressed in simple analytical form. As a general rule, they are obtained numerically and given in the form of tables and graphs. The last chapter deals with the problem of the stability of cyclotron radiation.

33486 Anomalous skin effect in plasmas. Dikman, S.M. (Physics Laboratory, Institute of Physical Problems, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 303-308(Jul 1976).

In an analysis of the anomalous skin effect in a plasma, the model of a plasma cylinder with a diffuse boundary is adopted. The relationship between the asymptotic behavior of the field of the electromagnetic wave outside the plasma and the electrical properties of the plasma is used to calculate the power absorbed in the plasma, the resistance per unit length, and the coefficient for wave reflection from the plasma. The solutions found are valid for a Gaussian radial profile of the electron density, n/sub e/=n/sub o/ exp(-r^2/a^2). Both electric and magnetic cylindrical waves are considered. Significantly, the results found for the limiting case of the anomalous skin effect are valid for an arbitrary ratio fo the depth to which the field penetrates into the plasma to the scale dimension of the plasma. In the case of a strong skin effect, the energy absorption in the plasma has resonant singularities at external-field frequencies ω=nv-bar/a, where n=1,2,3..., and v-bar= (2t/sub e//m/sub e/)$^{1/2}$ is the electron thermal velocity.

33487 Inclusion of impurity equations in the 1-D diffusion code of F.A.R. Mercier, C.; Papoular, R.; Soubbaramayer; Werkoff, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). *Plasma Phys.;* **18**: No. 11, 873-874(Nov 1976).

Impurity behaviour in Tokamak experiments is represented by the inclusion of impurity equations in the one-dimensional toroidal transport code of Fontenay-aux-Roses.

33488 Note on the generalized sheath criterion. Allen, J.E. (Oxford Univ. (UK). Dept. of Engineering Science). *J. Phys., D (London);* **9**: No. 16, 2331-2332(11 Nov 1976).

It is shown that the generalized form of the sheath criterion corresponds to 'sonic flow' at the plasma boundary.

33489 Transport of a multiple-ion species plasma in the Pfirsch—Schlueter regime. Hirshman, S.P. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 4, 589-598(Apr 1977).

The classical parallel friction coefficients, which relate the collisional friction forces to the flow of particles and heat along the magnetic field, are calculated for a multiple ion species plasma. In the short mean-free-path regime, the neoclassical Pfirsch—Schlueter transport coefficients for a toroidally confined multispecies plasma are computed in terms of the classical friction coefficients. The dependence of the neoclassical cross-field transport on the equilibration of the parallel ion temperature profiles is determined.

33490 Improved model for parallel-plate drift-tube experiments. Whealton, J.H.; Burch, D.S.; Phelps, A.V. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80309). *Phys. Rev., A;* **15**: No. 4, 1685-1695(Apr 1977).

The validity of analysis of parallel-plate drift-tube experiments by use of diffusion theory is examined. Monte Carlo simulations demonstrate the inadequacy of such analyses for electron motion near an absorbing cathode. However, diffusion theory results are verified for situations in which cathodic absorption is negligible, provided that a parameter β, the ratio of energy relaxation distance to drift-tube length, is much smaller than unity. For experimental circumstances in which cathode effects may be distinguished from those of anodic absorption, circuit time constant, and ionization, the Monte Carlo results can be used to augment diffusion theory for interpretation of the observed transients in terms of transport coefficients.

33491 On an inhomogeneous diffusion equation found in plasma physics. Lonngren, K.E. (University of Iowa, Iowa City, Iowa 52242). *J. Appl. Phys.;* **48**: No. 4, 1480-1482(Apr 1977).

Analytical solutions using the method of self-similar solution of partial differential equations are obtained for the inhomogeneous diffusion equation (partialrho/partialt)-(partial/partialx)[D$_0$x/sup m/(partialrho/partialx)]=0. Several diffusion problems found in plasma physics are characterized by this equation.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 33349

33492 Thermal-force terms and self-generated magnetic fields in laser-produced plasmas. Colombant, D.G.; Winsor, N.K. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev. Lett.;* **38**: No. 13, 697-701(28 Mar 1977).

The several magnetic-source terms affecting laser-produced plasmas are presented and their importance discussed. The thermal force is shown to greatly modify the magnetic-field distribution in numerical simulations. Experimental implications are also discussed.

33493 Sheath inverse bremsstrahlung in laser produced plasmas. Catto, P.J.; More, R.M. (Laboratory for Laser Energetics, College of Engineering and Applied Sciences, University of Rochester, Rochester, New York 14627). *Phys. Fluids;* **20**: No. 4, 704-705(Apr 1977).

During reflection from a sheath, electrons originating in the overdense plasma absorb laser light.

33494 Two-dimensional analysis of thermal induction plasmas in finite cylinders. Eckert, H.U. (The Aerospace Corporation, El Segundo, California 90009). *J. Appl. Phys.;* **48**: No. 4, 1467-1472(Apr 1977).

The temperature field of a static thermal induction plasma, enclosed in a cylindrical container, is calculated from an approximate closed-form solution of the Elenbaas-Heller equation without radiation term. By the assumption that the induced electric field has only a radial dependence, the heat conduction potential can be separated into its radial and axial dependences. Integration of the latter yields a cosine function; solution of the former is obtained by Picard's iteration method with a previously obtained Bessel-function solution for the infinite cylinder serving as zeroth approximation. The two integration constants are determined by the conditions of zero wall temperature and equality between dissipated rf power and heat conduction losses at the side and end walls. The method is applied to an argon plasma at atmospheric pressure. It is then shown how the results can be refined by including the quartz walls into the heat conduction system, so that the temperature variation along the plasma-wall interface is obtained.

33495 Plasma production by irradiating freely falling deuterium pellets with a high-power laser. Baumhacker, H.; Brinkschulte, H.; Lang, R.S.; Riedmueller, W.; Salvat, M. (Max-Planck-Institut fuer Plasmaphysik, Garching, West Germany). *Appl. Phys. Lett.;* **30**: No. 9, 461-463(1 May 1977).

A high-power Nd : glass laser beam was focused on freely falling deuterium ice pellets. It was demonstrated that this method allows reliable and reproducible production of an isolated deuterium plasma cloud suitable for filling a plasma machine. The plasma with a total ion number of (1—2) x 10^{17} expands quite uniformly at a velocity of (1—3) x 10^7 cm/s. However, the pellet is not completely ionized, which is in accordance with theoretical predictions. The greater portion of the pellet disintegrates after the laser shot and expands with a velocity of approximately 1 x 10^6 cm/s.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 33457, 33458

33496 (FRNC-TH—631) Theoretical and experimental study of trapped particle echoes in a magnetic mirror machine. Application to diffusion study. Chatelier, M. (Paris-11 Univ., 91 - Orsay (France)). 1976. 147p. (In French). NTIS (US Sales Only).

Thesis.

A simple mechanical model is used to investigate the various physical mechanisms originating the echoes. The model is applied to nuclear spins and echoes from particles trapped in a magnetostatic well. The theory of echoes from trapped ions in a magnetic machine is developed. The effects that may be observed when two magnetic perturbations are applied to the plasma are described. Diffusion effects in the velocity space are then taken into account when the diffusion is due either to Coulomb collisions or to a microturbulence at the ion cyclotron frequency. The experimental results obtained with the DECA II B machine are described. Emphasis is put upon the effects observed when magnetic perturbations are applied to the plasma and echoes observation independently of the diffusion study, as it is the first time that trapped particle echoes are observed in a hot plasma.

33497 Possibility of suppressing volumetric modes of plasma flute instability in an open trap by an electrode feedback system sistemoj obratnykh svyazej. Arsenin, V.V.; Chuyanov, V.A. *At. Energ. (USSR);* **39**: No. 5, 350-352(Nov 1975). (In Russian).

Short communication only; for English translation see the journal Sov. J. At. Energy.

33498 Feedback control for plasma equilibrium in ORMAK. Anderson, J.L.; Booth, R.S.; Colchin, R.J.; Miskell, R.V. (Oak Ridge National Lab., Tenn. (USA)); Bailey, J.M. (Tennessee Univ., Knoxville (USA)). *Nucl. Fusion;* **16**: No. 4, 629-637(1976).

Absolute feedback control of the horizontal plasma position has been implemented on the ORMAK [1] tokamak. Position control was accomplished by combining a pre-programmed vertical field current with a corrector current. The pre-programmed current was that predicted from optimum control theory, based on an approximate knowledge of plasma conditions. The corrector current, which usually is different for each shot, was derived from an on-line computation of the position of the outer poloidal magnetic flux surface. As a result of these controls, this surface can be held constant to within a few millimetres throughout the bulk of the discharge. In practice, the outer poloidal flux surface is deliberately shifted inward so that the centre of the magnetic field it produces is at the geometric centre of the torus.

33499 Stability of a combined l=0, l=1 diffuse configuration. Berge, G.; Freidberg, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Fusion;* **16**: No. 4, 651-660(1976).

The stability of a diffuse high-β, l=0, l=1 Scyllac configuration has been investigated. The optimum ratio of l=0 to l=1 fields is calculated in order to minimize the m=1 growth rate. The optimum case scales similarly to sharp-boundary predictions but requires a relatively smaller amount of l=0 field. The growth rate at optimum conditions is about 20-30% lower than that predicted by sharp-boundary theory.

33500 Aspects of the equilibrium and stability of counterstreaming-ion tokamaks. Cordey, J.G.; Haas, F.A. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **16**: No. 4, 605-611(1976).

An anisotropic high-β equilibrium is derived for the counterstreaming-beam tokamak (CBT). The critical β of the CBT is found to be of comparable magnitude to that occurring in a similar model of a scalar-pressure tokamak. It is shown that the toroidal current which is essential for equilibrium can be maintained by the counterstreaming ions. Finally, a brief discussion of the stability of the device is given.

33501 Decrease of the parametric instability threshold while electron beam injection in a plasma. Gromov, S.N.; Pasechnik, L.L.; Semenyuk, V.F. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). *Zh. Eksp. Teor. Fiz., Pis'ma Red.;* **23**: No. 3, 145-148(5 Feb 1976). (In Russian).

Letter-to-the-editor; for English translation see the journal JETP Lett.

33502 Trivelpiece mode in a magnetized plasma. II. Instability in an electron beam-plasma system. Miyama, N.; Idehara, T.; Ishida, Y. (Fukui Univ. (Japan). Faculty of Engineering). *Fukui Daigaku Kogakubu Kenkyu Hokoku;* **24**: No. 1, 85-92(Mar 1976). (In Japanese).

Below the electron cyclotron frequency, specially growing and damping waves are excited by a coaxial probe in a beam-plasma system. The former is a beam wave amplified by a reactive-medium instability, from the fact that its characteristics is very similar to those of a beam wave excited by mesh-modulation of a beam. While, the latter is considered to be a Trivelpiece mode of plasma, from the comparison of the experimental results with its dispersion relation derived theoretically.

33503 Plasma stability in systems with closed lines of force. Frolenkov, A.V. (I. V.,Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 373-375(Jul 1976).

The necessary condition for the hydromagnetic stability of a plasma derived by Mikhailovskii for arbitrary local perturbations is applied to systems with zero rotational transform. A study is made of the differences in terms of the most dangerous perturbations between such systems and systems which do have a rotational transform. For configurations with a planar magnetic axis, perturbations which are elongated along the plane of the magnetic axis turn out to be most dangerous near the axis.

33504 Method for suppressing current-convective instability. Tokar', M.Z. (Institute of High Temperatures, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 381-383(Jul 1976).

By examining the equations of motion, the possibility of inhibiting the current-convective instability by means of the radial component of a magnetic field is explored. (AIP)

33505 Formation of convective cells, anomalous diffusion, and strong plasma turbulence due to drift instabilities. Cheng, C.Z.; Okuda, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **38**: No. 13, 708-711(28 Mar 1977).

Large-scale, fully three-dimensional particle simulations have been carried out for the collisionless drift instabilities in a cylindrical geometry. It is found that nonlinear excitation of convective cells ($\omega=0, k_{\parallel}=0$) due to drift instabilities gives rise to enhanced turbulence and anomalous plasma diffusion. The observed power spectra have resemblance with the recent measurements in toroidal devices.

33506 Stability regions and growth rates for a two-ion component plasma, unmagnetized. Mynick, H.E.; Gerver, M.J.; Birdsall, C.K. (Electronics Research Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **20**: No. 4, 606-612(Apr 1977).

A uniform plasma, with a thermal core and a warm ring, in velocity space, is examined for instabilities. The parameters are the ratio of ring to core densities, the ratio of core thermal velocity to ring peak velocity, and the ring thermal velocity. The boundary between stable and unstable distributions is given, as dependent on these parameters, as obtained from the Penrose criterion. In addition, the upper and lower bounds on the wavenumbers (k/k_{min}) are found for typical distributions, as well as growth rates, $\omega/\omega_i(k)$. For either dense ring or dense core distributions, the distributions are unstable for (v_t/v_r) approximately-less-than0.1, independent of the thermal spread of the ring, where v_t is the core thermal spread, and v_r is the ring peak speed. For more equal ring and core densities, the stability boundary moves to larger values, dependent on the thermal spread of the ring. Growth rates of ω/ω_i0.01 to 0.1 ω/ω_p are typical. Application of these results to magnetized plasmas is given.

33507 Study of trapped electron instabilities driven by magnetic curvature drifts. Ross, D.W.; Tang, W.M.; Adam, J.C. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 4, 613-618(Apr 1977).

The trapped electron instability in tokamaks is investigated numerically for a range of physical parameters in which the large aspect ratio expansion is not valid. The frequency and growth rate are determined as functions of $\epsilon=r/R$, $\epsilon_t=(R\,d\ln T/d\ln n)^{-1}$, $\eta_e=d\ln T/d\ln n$, and $b=(k\rho_i)^2/2$. In particular, the relationship of the usual drift wave, driven by trapped electron Landau resonances or collisions, to a nonresonant mode described by Coppi and Rewoldt is studied. It is verified that the latter, on the one hand, is obtained as a continuation of the former to large b, and, on the other hand, has a qualitatively different behavior. For sufficiently small ϵ_t, and for normal density gradients ($\eta_e<$ or $=0$), the mode can reverse and propagate in the ion diamagnetic direction. Explicit criteria for this to happen are derived, and the scaling of the resulting growth rates for large b is obtained. In the collisionless limit, these nonresonant growth rates can exceed those of the usual drift waves. It is therefore necessary to consider the effects of collisions, particularly those of the ions, whose effect increases as ν_i/b. By means of a simple model, it is shown that the electron collisions have a small damping effect, which cannot stabilize the large b modes. The ion collisions can, however, reduce the growth rates of the large b modes below those of the drift waves. A criterion for this is derived and compared with the numerical results.

33508 Finite-bandwidth control of fast electrons produced by parametric instability. Obenschain, S.P.; Luhmann, N.C. Jr. (University of California, Los Angeles, California 90024). *Appl. Phys. Lett.;* **30**: No. 9, 452-454(1 May 1977).

In a microwave experiment simulating laser-plasma interactions, the production of fast electrons by the parametric decay instability is found to be significantly decreased by replacing a monochromatic pump with a noisy one. With this experimental arrangement, it is observed that finite bandwidth also inhibits the formation of density cavitons.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 33444, 33445, 33448, 33466

33509 (IPPJ—231) Modified nonlinear schroedinger equation for Alfven waves propagating along the magnetic field in cold plasmas. Mio, K.; Ogino, T.; Minami, K.; Takeda, S. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1975. 22p. TIC.

The basic nonlinear equation which describes the Alfven waves, with small but finite amplitude propagating along the magnetic field in cold plasmas is derived modifying the reductive perturbation method proposed by Taniuti and Wei. Then as a result, the nonlinear dispersion relation is obtained through a procedure which clarifies the physical meaning. Furthermore, the modified nonlinear schroedinger equation is proposed which describes the modulated Alfven wave more correctly than the previous works. Our analysis agrees well with the numerical calculation of the initial value problem using the basic equations.

33510 (IPPJ—233) Wave propagation near the lower hybrid resonance in toroidal plasmas. Ohkubo, K.; Ohasa, K.; Matsuura, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1975. 27p. TIC.

Dielectric tensor and equipotential curves (ray trajectories) of an electrostatic wave near the lower hybrid resonance are investigated for the toroidal plasma with a shear magnetic field. The ray trajectories start from the vicinity of the plasma surface, and rotate in a spiral form around the magnetic axis, and then reach the lower or upper parts of lower hybrid resonance layer. The numerical computations are performed on the parameters of JIPP T-II device with two dimensional inhomogeneity.

33511 (IPPJ—236) Modulational instability and envelope-solitons for nonlinear Alfven waves propagating along the magnetic field in cold plasmas. Mio, K.; Ogino, T.; Minami, K.; Takeda, S. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1975. 22p. NTIS (US Sales Only).

The modulational instability and envelope-solitons for the Alfven waves propagating along the static magnetic field in cold collisionless plasmas are analyzed using the modified nonlinear Schroedinger equation derived previously by the authors. It is shown that the modulational instability exists for a small amplitude but does not for a amplitude larger than the critical value in the case of the left-hand circularly polarized Alfven wave (left Alfven wave). On the other hand, the modulational instability does not exist for the right=hand circularly polarized Alfven wave (right Alfven wave). Without the modulational instability, the rarefactive and compressive envelope-solitons exist for the left Alfven wave and the two types of the rarefactive envelope-solitons for the right Alfven wave.

33512 Trivelpiece mode in a magnetized plasma. I. Dispersion relation. Miyama, N.; Idehara, T.; Ishida, Y. (Fukui Univ. (Japan). Faculty of Engineering). *Fukui Daigaku Kogakubu Kenkyu Hokoku;* **24**: No. 1, 79-84(Mar 1976). (In Japanese).

By means of coaxial probe antenna, Trivelpiece mode is excited in magnetized plasma column. Measuring the propagating wave patterns by using an interferometer system, the dispersion relation is determined experimentally. Wave surface obtained from these patterns suggests that the wave is backward one in the direction across the field. These result can be explained consistently by the theoretical consideration.

33513 Nonlinear interaction of high frequency electromagnetic field with a nonuniform plasma. Akiyama, H.; Kando, M.; Minami, Kazuo; Takeda, S. (Nagoya Univ. (Japan). Faculty of Engineering). *Nippon Seirigaku Zasshi;* **40**: No. 3, 839-845(Mar 1976).

Nonlinear interactions between a high frequency electromagnetic field and a plasma in a cavity are experimentally studied. The electric field is perpendicular to the density gradient. A low frequency oscillation is observed when the angular frequency ω_o of the electromagnetic field is nearly equal to the maximum plasma frequency ω_{pm}. It is attributed to a parametric decay process which is confirmed by observing the frequency matching condition and the dispersion relation for the excited low frequency wave. The threshold intensity of the pumping field is considerably higher than the value predicted by the theory in uniform plasmas. The effective collision frequency ν_{eff} measured in the cavity has two distinct breaking points as the power of the high frequency field increases. When ω_o is lower than ω_{pm}, the local decrease of the electron density observed at a point of ω_o asymptotically equals ω_p, the local Langmuir frequency, is explained in terms of the ponderomotive force of the amplified, local electromagnetic field.

33514 rf waves in nonequilibrium-plasma accelerator. Kirdyashev, K.P.; Potapov, A.V.; Tsvetkova, L.E.; Bozhko, I.D.; Chukhlantsev, A.A. *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 296-300(Jul 1976).

The wave intensity has been measured over the frequency range 500-3000 MHz in an electrodynamic discharge intended for accelerating plasma, both in the cross section and along the length

oii the plasma stream. The estimated phase velocities of the excited waves correspond to the velocities of the fast electrons in the cathode region of the discharge. A mechanism of an rf instability involving fast electrons in the discharge is discussed; this agrees qualitatively with the experimental results.

33515 Parametric excitation of drift waves. Vlasov, V.V.; Kitsenko, A.B.; Panchenko, V.I.; Rozhkov, A.M.; Stepanov, K.N.; Farenik, V.I. (A. M. Gor'kii Khar'kov State University). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 338-343(Jul 1976).

An experimental study is reported of the consequences of the excitation of high- and low-frequency drift waves in a weakly ionized, inhomogeneous plasma in a constant external magnetic field and a varying external electric field. The frequency of the pump field, ω_0, was approximately equal to the frequency of the high-frequency drift waves, ω_1. The waves are excited under decay conditions, with $\omega_0$vertical-bar$\omega_1$vertical-bar+ω_2(ω_2 is the frequency of the low-frequency drift waves), and have a threshold nature. A theoretical analysis of the possible effects under these experimental conditions is reported. The experimental and theoretical results are in good qualitative agreement.

33516 Excitation of difference-frequency waves in interaction of microwaves at the upper hybrid resonance. Bakai, A.S.; Vasil'ev, M.P.; Voitsenya, V.S.; Voloshko, A.Y.; Kulaga, E.A.; Nazarov, N.I.; Perepelkin, N.F.; Solodovchenko, S.I.; Shtan', A.F. (Physico-technical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 383-384(Jul 1976).

A saturn stelleration was employed to study the excitation of rf waves through the mixing of two microwave signals. The waves were observed primarily near the zone of the electron cyclotron resonance. (AIP)

33517 Three wave interactions in a beam-plasma-system in a cylindrical waveguide. Khan, T.P. (Dinabandhu Andrews College, Garia, West Bengal (India)); Roy, S.R. (Jadavpur Univ., Calcutta (India)). *Ann. Phys. (Leipzig);* **33**: No. 5, 321-328(Sep 1976).

The nonlinear interaction of three waves in a hot plasma cylinder generated by an ion beam are considered. The finite beam-plasma system was assumed to be placed in vacuum inside a circular waveguide. A set of equations that govern the axial variations of mode amplitudes in three wave interaction has been derived and the dispersion relation and the axial growth rate have been obtained.

33518 Macroscopic plasmadynamical modes in a complete two-fluid description. Balescu, R. (Brussels Univ. (Belgium). Faculte des Sciences); Paiva-Veretennicoff, I. *J. Plasma Phys.;* **16**: No. 2, 119-127(Oct 1976).

An analysis is presented of the linearized plasma-dynamical equations, including the energy conservation equations, and accounting completely for all the dissipative mechanisms, in the absence of external fields. The eigenvalues of the 14 plasmadynamical modes are obtained systematically in terms of the transport coefficients of the plasma.

33519 Eigenoscillations of the ion cyclotron beam-whistler turbulence excited in collisionless parallel shock waves. Chen, L.; Golden, K.I. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Phys. Lett., A;* **58**: No. 7, 462-464(18 Oct 1976).

Eigenstructures and growth rates are obtained for the ion cyclotron beam-whistler plasma instability near the leading edge of a shock wave propagating along the magnetic field.

33520 Observation of diverging cylindrical solitons excited with a probe. Chen, T.; Schott, L. (Regina Univ., Saskatchewan (Canada)). *Phys. Lett., A;* **58**: No. 7, 459-461(18 Oct 1976).

Ion acoustic solitons are excited using a large cylindrical probe enclosed in an insulator. Their speed is smaller than that of plane or converging solitons and their width increases as they travel away from the probe.

33521 Effect of random inhomogencities on nonlinear ion-acoustic waves. Sharma, A.S.; Buti, B. (Physical Research Lab., Ahmedabad, India). *IEEE Trans. Plasma Sci.;* **PS-4**: No. 4, 284-286(Dec 1976).

The envelope characteristics of long wavelength nonlinear ion-acoustical waves in the presence of random density inhomogeneities are studied. These waves are found to be modulationally stable and hence admit envelope hole solutions. The width of the envelope hole is increased due to the increased dispersions of the plasma.

33522 Measurements on wave propagation characteristics of spiraling electron beams. Singh, A. (Southern Univ., Baton Rouge, LA); Getty, W.D. *IEEE Trans. Plasma Sci.;* **PS-4**: No. 4, 287-291(Dec 1976).

Wave propagation characteristics of cyclotron-harmonic waves propagating on a neutralized spiraling electron beam immersed in a uniform axial magnetic field have been studied experimentally. All electrons in the beam have the same rotational speed and axial velocity and are uniformly distributed over the cross section. The results of measurements are presented in the form of ω-k plots and are compared with those obtained numerically from the dispersion relation.

33523 Modulational instability of ion-acoustic waves in collisional plasmas. Buti, B. (Physical Research Lab., Ahmedabad, India). *IEEE Trans. Plasma Sci.;* **PS-4**: No. 4, 292-295(Dec 1976).

Nonlinear ion-acoustic waves, which in the absence of collisions are moderately stable in the long wavelength limit, become modulationally unstable due to presence of collisions. These waves are unstable in the wave number range k/sub min/ less than k less than k/sub max/.

33524 Stochastic acceleration by an electrostatic wave near ion cyclotron harmonics. Fukuyama, A.; Momota, H.; Itatani, R.; Takizuka, T. (Department of Electronics, Kyoto University, Kyoto, Japan). *Phys. Rev. Lett.;* **38**: No. 13, 701-704(28 Mar 1977).

We study a nonlinear effect on ion motion of an electrostatic wave propagating perpendicularly to a uniform magnetic field. When the wave near the ion cyclotron harmonics has sufficiently large amplitude, the trapped motions of hot ions (ν/sub perpendicular/$<\omega$/k/sub perpendicular/) become stochastic in the region of appreciable width near the separatrix. Numerical calculations show the tail formation in a ν/sub perpendicular/ distribution and theoretically predicted upper bound conditioned by the amplitude.

33525 Resonance cones in a warm magnetized bounded plasma. Grabbe, C.L. (California Institute of Technology, Pasadena, California 91125). *Phys. Fluids;* **20**: No. 4, 599-605(Apr 1977).

The resonance cone structure in a warm bounded slab magnetoplasma has been obtained in the electrostatic approximation for small electron and ion temperatures and a large magnetic field. It is found that the conducting boundaries act as perfect mirrors as in the cold plasma case; the cones reflect off the boundaries without any distortion of shape. The thermal effects produce the shifting of the maximum of the potential and the appearance of an interference structure inside each cone as in unbounded plasma theory. The amount of the shift is a uniformly increasing function of the axial distance from the source of each cone, while the spatial frequency is a uniformly decreasing function of that distance. Because of the spreading, there is significant interference between nearby cones, so the total potential is more complicated than in the unbounded case. The solution is first obtained for a homogeneous plasma and studied, and then extended to the inhomogeneous plasma. The effects of Landau and collisional damping are included.

33526 Induced wave scattering at low phase velocities. Choi, D.; Horton, W. Jr. (Fusion Research Center, Department of Physics, University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 4, 628-633(Apr 1977).

By considering the induced wave scattering of low phase velocity waves, the breakdown point of the small amplitude expansion forming the basis of weak turbulence theory is investigated in detail. A possible observation of the transition point from the weak turbulence theory to the renormalized turbulence theory by comparing the calculation and the particle simulation is suggested.

33527 Plasma ringing associated with pulsed resonance cones. Bellan, P.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 4, 649-653(Apr 1977).

A temporal wave packet of frequency ω_0(ω/sub c i/, ω/sub p i/very-much-less-than$\omega_0$very-much-less-thanω/sub c e/, ω/sub p e/) applied to a finite antenna in a magnetically confined plasma, is shown to excite an electrostatic field consisting of (1) a short-duration resonance cone and (2) a wave-like disturbance which follows afterward. This latter disturbance, which is related to the lower frequency mode of the delta-function induced transients discussed by Simonutti, persists long after the resonance cone. The phase factor associated with the disturbance is independent of ω_0, and its constant-phase surfaces are lines which emanate from the antenna and make a small angle θ with respect to the confining magnetic field B. θ decreases with increasing time so that "wavelengths" perpendicular to B also decrease with increasing time. The correspondence of the fields obtained by wave-packet excitation to those obtained by both cw and delta-function excitations is discussed and experimental results are reported.

33528 Surface modes in electron plasmas. Hopps, J.H.; Waldron, W.L. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., A;* **15**: No. 4, 1721-1729(Apr 1977).

Density fluctuations in a semi-infinite collisional electron plasma are studied using "two-stream" distribution functions. Microscopic boundary conditions, imposed separately upon each of the velocity streams, are formulated with the inclusion of both specular reflection and diffuse scattering contributions. The strong damping of surface modes noted by previous investigators is shown to be, in part, a consequence of the use of pure specular reflection boundary conditions. With increasing diffuse scattering contributions the sur-

face modes are seen to become an enhanced and identifiable spectral feature.

33529 Comments on "electromagnetic interaction with bounded slab media moving normal to the interface". Mukherjee, P.K. (Department of Physics and Astrophysics, University of Delhi, Delhi-110007, India). *J. Appl. Phys.;* **48**: No. 4, 1766(Apr 1977).

It is argued that in dealing with electromagnetic interaction with a bounded slab moving perpendicular to the interface with relativistic speed, a correct treatment must take account of the Lorentz contraction of the slab thickness. basis functions of the reducible representation of the system are the following seven Slater functions: the

THERMONUCLEAR POWER PLANTS

33530 (AED-Conf—76-309-037, pp 39) **THOR Tokamak - engineering design and proposed diagnostic facilities.** Fontanesi, M. (Milan Univ. (Italy)); Worsnop, P.A. (UKAEA Research Group, Abingdon. Culham Lab.). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

Short communication only. Available from ZAED.

In 9th symposium on fusion technology. Abstracts.

33531 (AED-Conf—76-309-038, pp 40) **Technological aspects of the WEGA stellarator.** Fritsch, R.; Ohlendorf, W.; Pacher, G.W.; Pacher, H.D.; Wegrowe, J.G. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F.R. Germany)); Lipa, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

Short communication only. Available from ZAED.

In 9th symposium on fusion technology. Abstracts.

33532 (AED-Conf—76-309-062, pp 64) **Fiscatron fusion reactor concept.** Fischer, A.G. (Dortmund Univ. (F.R. Germany)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

Short communication only. Available from ZAED.

In 9th symposium on fusion technology. Abstracts.

33533 (IAE—2370) **Tokamak devices. 1. Theory, design, diagnostics.** Artsimovich, L.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1974. 41p. (In Russian). NTIS (US Sales Only).

38 refs.; 17 figs.

The survey deals with investigations on plasma in toroidal systems with a high longitudinal field (tokamak facilities). The motion of separate particles in such systems is discussed; theoretical works on plasma equilibrium, transport coefficients, and stability are reviewed. Designs of tokamak facilities and the plasma diagnostic methods used on them are described.

33534 9th symposium on fusion technology at Garmisch-Partenkirchen. Buende, R. *Brennst.-Waerme-Kraft;* **28**: No. 10, 401(Oct 1976). (In German).

From 9. symposium on fusion technology; Garmisch-Partenkirchen, Germany, F.R. (14 Jun 1976).

The article gives a short outline of the reports written for the symposium. They were divided under the ten following subjects: the handling of plasma, data recording and processing, automatic control, electric equipment, experimental arrangements, first wall und blanket, tritium problems, vacuum technology, magneto-technology, as well as the study of systems and new projects.

PHYSICS AND BLANKET ENGINEERING

33535 (EUR-CEA-FC—830) **Diffusion in tokamaks with impurities in the Pfirsch Schluter regime.** Samain, A.; Werkoff, F. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jun 1976. 29p. NTIS (US Sales Only).

Particle transport due to collisions between impurity ions and light ions in Tokamak devices is studied. Impurity ions are assumed to be in the Pfirsch-Schluter regime whenever light ions are either in the Pfirsch-Schluter regime or in the banana or the plateau regime. Transport coefficients were calculated in both cases.

33536 (JAERI-M—6297) **Recycling process of impurities in tokamak discharges.** Gomay, Y.; Tazima, T. (Japan Atomic Energy Research Inst., Tokyo). Nov 1975. 14p. INIS.

In the recycling process of impurities in a plasma, only the sputtering of first wall materials is usually considered. In the present study, not only sputtering of metal but desorption of sorbed layers by particles and reflection of incident impurity ions at the limiter are also introduced. The behaviour of impurities in the discharges of recent Tokamaks is interpreted quantitatively and the result is applied to a future large Tokamak. The nonmetallic impurity concentrations may attain plateaus in the early stage of a discharge which are lower than the permissible levels, because the desorption yield by particles may probably be decreased by discharge cleaning. On the contrary the metallic impurity concentrations tend to increase beyond the permissible levels, since the self-sputtering yield of impurity ions will become larger than unity with the increase of plasma temperatures. In this respect the method to reduce the metallic impurities is important.

33537 (JAERI-M—6331) **Experimental apparatus to investigate interactions of low energy ions with solid surfaces. 1. Summary of the designs.** Tsukakoshi, O.; Narusawa, T.; Mizuno, M.; Sone, K.; Ohtsuka, H. (Japan Atomic Energy Research Inst., Tokyo). Dec 1975. 38p. TIC.

Experimental apparatus to study the surface phenomena has been designed, which is intended to solve the vacuum wall problems in future thermonuclear fusion reactors and large experimental tokamak devices. An ion source and the beam transport optics are provided for bombarding solid target surface with an ion beam of energy from 0.1 to 6 keV. Measuring instruments include an ion energy analyser, a quadrupole mass spectrometer, an Auger electron spectrometer, an electro-micro-balance, a neutral particle energy spectrometer and its calibration system. Pumping system consists of oil-free ultrahigh vacuum pumps. Various kinds of experiments will be carried out by using the apparatus: 1) sputtering by low energy ion bombardment, 2) re-emission of the incident particles during and after ion bombardment, 3) release of adsorbed and occluded gases in the solids by ion bombardment, and 4) backscattering of fast ions. The combinations of measuring instruments for each experiment and their relative positions in the vacuum chamber are described through detailed drawings. The fundamental aspect in design of the ion beam transport optics for a low energy ion beam which can no longer neglect the space charge effect is also discussed.

33538 (JAERI-M—6343) **Impurity-evolution code IMPHPCG and analysis of the impurity measurements for JFT-2 tokamak.** Okamoto, M.; Amano, T. (Japan Atomic Energy Research Inst., Tokyo). Dec 1975. 44p. NTIS (US Sales Only).

The code IMPHPCG has been prepared to study the evolution of impurities in a Tokamak plasma. It evaluates the development of impurity profiles for the given temporal and spatial plasma densities, temperatures and currents. The diffusion of impurities is assumed as neo-classical in the banana-plateau region. The spectroscopic measurement of oxygen and carbon impurities in JFT-2 Tokamak is analysed with the code.

33539 Comment on "Generalized criterion for feasibility of controlled fusion and its application to nonideal dd systems" by B. C. Maglich and R. A. Miller. Pistunovich, V.I. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 387(Jul 1976).

The energy-balance criterion derived by Maglich and Miller for thermonuclear reactions in steady-state DD and DT reators is considered. It is claimed that their results are invalid due to incorrect assumptions concerning plasma confinement technology. (AIP)

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 32959, 33553

33540 (IPPJ—232) **Importance of field-reversing ion ring formation in hot electron plasma.** Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1975. 11p. TIC.

Formation of the field-reversing ion ring in the mirror-confined hot electron plasma may offer a device to confine the fusion plasma even under the restriction of the present technology.

33541 Fusion reactor with picket-fence walls. Hershkowitz, N.; Dawson, J.M. (California Univ., Los Angeles (USA). Dept. of Physics). *Nucl. Fusion;* **16**: No. 4, 639-642(1976).

It is shown that a fusion reactor with surface magnetic cusp walls may be feasible, based on recent experiments which find cusp leaks of the order of the hybrid gyroradius.

POWER SUPPLIES AND CIRCUITRY

33542 (KFTI—74-44) **Power and signal-information circuits for hf plasma heating.** Kalinichenko, S.S.; Kurilko, P.I.; Shvets, O.M. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 33p. (In Russian). NTIS (US Sales Only).

20 refs.; 1 table; 14 figs.

Along with the detailed characteristic of plasma as a load, the paper discusses various types of HF oscillators and their utilization

for plasma HF heating. Various circuits of matching excitation devices with oscillators and types of feeders are analyzed. Practical circuits of various measuring devices are comprehensively described.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 33348

FUEL SYSTEMS

33543 (AED-Conf—76-309-000, pp 56) **Energy yield and fuel dynamics of the fusion breeder.** Harms, A.A.; Gordon, C.W. (McMaster Univ., Hamilton, Ontario (Canada)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

Short communication only. Available from ZAED.

In 9th symposium on fusion technology. Abstracts.

33544 (EUR-CEA-FC—831) **Neutral injector using an ion source at the electron cyclotron resonance.** Jacquot, C.; Ludwig, P.; Sermet, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jul 1976. 96p. (In French). NTIS (US Sales Only).

The problems connected with the use of an ion source operating at the electron cyclotron resonance to obtain neutral particles from negative ions are studied. Ionization efficiency, beam divergence, ion beam transport in a uniform B field and electron capture of D^+ on a narrow alcali target to produce D^- are examined. A new project of injector to create 0.3 A of negative ions is presented.

33545 **Electron distribution functions and quasi-static electromagnetic fields in laser-pellet plasmas.** Bernstein, I.B. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Fluids;* **20**: No. 4, 577-580(Apr 1977).

The theory of the electron distribution functions in a laser-pellet plasma is developed taking advantage of the dominance of collisions with high charge number ions. For the thermal electrons the result is a description in terms of transport coefficients given in closed form. For the superthermal electrons, which are isotropic in velocity, the description is via a reduced kinetic equation. The adaptation of the scheme to numerical computation is discussed briefly.

RADIATION HAZARDS

33546 (IPPJ—235, pp 27-43) **Design of steady state fusion burner.** Hasegawa, Akira (Bell Labs., Murray Hill, N.J. (USA)); Hatori, Tadatsugu; Itoh, Kimitaka; Ikuta, Takashi; Kodama, Yuji. Nov 1975.

From Daisen summer school (laser fusion workshop); Daisen, Tottori, Japan (16 Jul 1975).

In Daisen summer school.

We present a brief design of a steady state fusion burner in which a continuous burning of nuclear fuel may be achieved with output power of a gigawatt. The laser fusion is proposed to ignite the fuel.

POWER CONVERSION SYSTEMS

33547 (Juel—1304) **Energy balance and efficiency of power stations with a pulsed Tokamak reactor.** Davenport, P.A.; Mitchell, J.T.D.; Knobloch, A.; Darvas, J.; Foerster, S.; Sack, B. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jun 1976. 60p. TIC.

With figs., tabs. and refs.

The energy balance of a fusion power station based on the TOKAMAK concept is examined with the aid of a model comprising three distinct elements: the reactor, the energy converter and the reactor operation equipment. The efficiency of each element is expressed in terms of the various energy flows and the product of these efficiencies gives the net station efficiency. The analysis takes account of pulsed operation and has general applicability. Numerical values for the net station efficiency are derived from detailed estimates of the energy flows for a TOKAMAK reactor and its auxiliary equipment operating with advanced energy converters. The derivation of these estimates is given in eleven appendices. The calculated station efficiencies span ranges similar to those quoted for the current generation of fission reactors, though lower than those predicted for HTGR and LMFBR stations. Credible parameter domains for pulsed TOKAMAK operation are firmly delineated and factors inimical to improved performance are indicated. It is concluded that the net thermal efficiency of a TOKAMAK reactor power station based on present designs and using advanced thermal converters will be approximately 0.3 and is unlikely to exceed 0.33.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 32995, 32996, 32998, 32999, 33000, 33001, 33492, 33493, 33495, 33545

33548 (AED-Conf—76-379-002) **Laser fusion.** Ashby, D.E.T.F. (UKAEA Research Group, Abingdon. Culham Lab.). 1976. 20p. (CONF-760995—2). NTIS (US Sales Only).

From 40. physicists' meeting; Bonn, German, Federal Republic of (F.R. Germany) (14 Sep 1976).

3 figs.; 12 refs.

A short survey is given on laser fusion its basic concepts and problems and the present theoretical and experimental methods. The future research program of the USA in this field is outlined.

33549 (IPPJ—230) **Analytical model for super-compression of multi-structured pellet.** Yabe, T.; Niu, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Sep 1975. 13p. NTIS (US Sales Only).

We present a one-dimensional analytical model which can be applied to the super-compression of the multistructured pellet. The main result shows that the time dependence of the input power E for the optimal compression is given by E proportional to (1 - t/tsub(s))sup(-3(G+1)/2G) where $G=(\rho_{o_1}/\rho_{o_2})^{1/4}$, ρ_{o_1} and ρ_{o_2} are the densities of the D-T fuel and the high Z material respectively, and tsub(s) if the characteristic time interval.

33550 (IPPJ—235) **Daisen summer school. (Laser fusion workshop).** (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1975. vp. (CONF-750781—). NTIS (US Sales Only).

From Laser fusion workshop; Daisen, Tottori, Japan (16 Jul 1975).

A separate abstract for each paper was entered into the data base. (MOW)

33551 (IPPJ—235, pp 44-57) **Magnetically focused fast ion in laser target plasma.** Itoh, K.; Inoue, S. (Tokyo Univ. (Japan). Dept. of Physics). Nov 1975.

From Daisen summer school (laser fusion workshop); Daisen, Tottori, Japan (16 Jul 1975).

In Daisen summer school.

Fast ion generation in the laser target plasma is investigated including the effect of strong magnetic field. Hot electron generates electric field parallel to the laser light and azimuthal magnetic field. A meandering duct, in which ions are accelerated along the magnetic null line, appears in this configuration. Outwide the duct E vector x B vector and B vector x nabla B vector drifts play main roles. It is shown that the ion focusing process depends on the direction of the magnetic field.

33552 (IPPJ—235, pp 13-18) **Filamentation and decay of laser light in plasmas.** Nishihara, K. (Nagoya Univ. (Japan). Dept. of Physics); Mima, K.; Mizui, J.; Inutake, M.; Tange, T. Nov 1975.

From Daisen summer school (laser fusion workshop); Daisen, Tottori, Japan (16 Jul 1975).

In Daisen summer school.

Filamentation of laser light is studied for a laser fusion plasma. We also discuss the importance of effects of a decay of the laser light into two plasma waves on the filament formation at one-quarter critical density.

33553 (IPPJ—235, pp 19-26) **Magnetic field generation due to resonance absorption.** Nishihara, K.; Ohsawa, Y. (Nagoya Univ. (Japan). Dept. of Physics); Mima, K.; Tange, T. Nov 1975.

From Daisen summer school (laser fusion workshop); Daisen, Tottori, Japan (16 Jul 1975).

In Daisen summer school.

A detailed study of mechanism of megagauss magnetic field generation in resonant absorption of laser light is presented which takes into account effects of both dissipation and thermal motion of electrons.

33554 (IPPJ—235, pp 6-12) **Two-step laser-driven fusion reactor.** Yabe, T. (Tokyo Inst. of Tech. (Japan)); Nishihara, K.; Mizui, J. Nov 1975.

From Daisen summer school (laser fusion workshop); Daisen, Tottori, Japan (16 Jul 1975).

In Daisen summer school.

We present a new type of laser fusion reactor which consists of a small core pellet and a large outer pellet.

33555 (JAERI-M—6285) **Theory of laser interaction with plasma.** Nishikawa, K. (Japan Atomic Energy Research Inst., Tokyo). Oct 1975. 20p. (In Japanese). INIS.

Fundamental physical processes in a plasma irradiated with intense laser pulses are reviewed. Parametric Instabilities are discussed in detail with emphasis on the nonlinear effect. Problems associated with the compression of solid targets and recent topics on the laser driven fusion are also described.

33556 **Criteria for the onset of flux-limited thermal conduction in laser-induced compression.** Ashby, D.E.T.F. (UKAEA Research

Group, Harwell. Atomic Energy Research Establishment). *Nucl. Fusion;* **16**: No. 4, 623-628(1976).

The conditions under which flux limitation of thermal conductivity begins to affect laser-induced compression by restricting the energy flow to the ablation zone are considered. On the assumption that the maximum thermal flux is given by Fsub(m) = α(1/4nsub(e)vsub(e))kT, a simple analytic model is used to show that flux limiting commences when the ratio of the critical radius to the ablation radius rsub(c)/rsub(a) approximately greater than (α/16)[(8AM)/(πmZ)]sup(1/2). The laser power at which this occurs varies as α^3/lambda^3. Computer modelling is used to check the validity of these predictions.

33557 Enhanced reflection of laser light from an expanding plasma. Begg, I.M.; Cairns, R.A. (Saint Andrews Univ. (UK)). *J. Phys., D (London);* **9**: No. 16, 2341-2348(11 Nov 1976).

If the expansion velocity of a laser-produced plasma is around the ion sound speed, then in the laboratory frame, it is possible to have standing ion sound waves together with pump and backscattered waves of equal frequency. Partial reflection of the pump wave from the high-density regions of the plasma can then lead, via stimulated Brillouin scattering, to enhanced reflection.

33558 Momentum transfer to target from laser-produced plasma. Kuriki, K.; Kitora, Y. (Institute of Space and Aeronautical Science, University of Tokyo, Komaba, Tokyo, 153, Japan). *Appl. Phys. Lett.;* **30**: No. 9, 443-446(1 May 1977).

The impact transferred from laser-produced plasma to target was measured, and the formed plasma was studied by schlieren and shadow photographs. The cylindrical detonation wave theory was in general agreement with the plasma features in the early energy deposition phase but failed to predict the momentum transfer from plasma to target. The momentum transfer agreed with the theory of spherical blast wave which follows the cylindrical detonation wave.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 32845, 33469

33559 (EUR-CEA-FC—818) **Control system of the Wega stellarator using a MICRAL G microcomputer.** Bescher, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1976. 91p. (In French). NTIS (US Sales Only).

A description of the WEGA device, the micro-computer and its input and output circuits, and the software, is given.

33560 (IAE—2425) **Vacuum systems for the IAE tokamaks.** Glukhov, A.V.; Krasnov, N.V.; Maslennikov, E.A.; Orlov, P.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1974. 14p. (In Russian). INIS.

9 refs.; 9 figs.

The paper describes vacuum systems of tokamak-type thermonuclear facilities consisting of a working chamber, a pumping system, and a hydrogen feeding system. It considers the problem of admission of impurities into the plasma from the vacuum system elements, and the ways for improving the vacuum conditions in the tokamak working chambers.

33561 (JAERI-M—6293) **Calculations on the projected range and its straggling for low energy (0.1-20 keV) light ions in the first wall materials.** Sone, K. (Japan Atomic Energy Research Inst., Tokyo). Nov 1975. 42p. (In Japanese). INIS.

Parameters involved in the study of plasma-wall interactions in fusion reactors have been calculated as a function of the ion energy, including the specific energy loss for energetic ions incident onto the vacuum wall, the projected range and its straggling. Calculations are based on the statistical theory developed by Lindhard and co-workers for the partition of energy as an energetic ion slowing-down. Some candidate materials and the constituent elements of the first wall are chosen, such as Mo, Nb, V, Fe, Ni and C, which are bombarded with light ions (H^+, D^+, T^+ and He^+) of energies 0.1 - 20 keV. Damage efficiency and average DPA in the displacement damage of lattice atoms in ion bombardment are also shown as a function of the energy. The computer program for the calculations is presented, which is able to calculate the parameters for other combinations of ions and wall materials.

33562 (JAERI-M—6330) **Preliminary results on dynamic magnetic limiter in JFT-2a tokamak.** Shimomura, Y.; Ohtsuka, H.; Maeda, H.; Yamamoto, S.; Kimura, H. (Japan Atomic Energy Research Inst., Tokyo). Dec 1975. 7p. TIC.

Experimental study has been performed on a dynamic magnetic limiter in JFT-2a (DIVA) Tokamak. The magnetic configuration can be changed within 1 ms by increasing or decreasing a divertor hoop current. The time variation of heat flux to the divertor region is measured with a conventional thermocouple by using the dynamic magnetic limiter; decreasing the divertor hoop current to zero at any given time.

33563 Sputtering of materials by H^+, D^+, T^+, and He^+ ions. Guseva, M.I.; Martynenko, Y.V. (I. V. Kuchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **2**: No. 4, 324-325(Jul 1976).

The sputtering coefficients for materials which are candidates for the first wall in thermonuclear reactor are calculated for sputtering by 1-keV H^+, D^+, T^+, He^+ ions. These calculations are based on the theoretical behavior of the sputtering coefficient as a function of the ion mass and energy and on the experimental values of the sputtering coefficient measured for the given material at some energy of one of the light ions (H^+, D^+, or He^+).

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 32309

33564 (AECL—5541) **Annual report 1975-1976.** (Atomic Energy of Canada Ltd., Ottawa, Ontario). 4 Jun 1976. 59p. NTIS (US Sales Only).

Progress, performance, and future plans are described for Canadian nuclear power plants, heavy water plants, nuclear research, commercial uses of radiation and radioisotopes, operations and administration, health protection, and collaboration with industry.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 31940, 32847, 33435

33565 (LA—6668-T) **Proof of convergence for the tridiagonal QL algorithm in floating-point arithmetic.** Sanderson, J.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 71p. Dep. NTIS $4.50.

Thesis.

Numerous routines are available to find the eigenvalues of a real symmetric tridiagonal matrix. Since it is known to converge in exact arithmetic, the tridiagonal QL algorithm with origin shift is widely used. This algorithm is analyzed here in floating-point arithmetic. This analysis suggests two modifications to the EISPACK implementation TQL1 that enable one to prove correctness and, hence, convergence of the routine. Also, it is known that the implicit and explicit versions of the QL algorithm produce the same results in exact arithmetic. A counter-example to the floating-point analog of this theorem is presented.

33566 (LA—6680-MS) **Final report on the HELPER project.** Schultz, D.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 40p. Dep. NTIS $4.00.

The HELPER minicomputer hardware and software capabilities are thoroughly explained and critically reviewed. HELPER is a cost-effective assistant to the present CCF system. The recommendations are to assign specific types of tasks to HELPER and to study the resulting effects on CCF users. Improvements to the present HELPER hardware are also suggested. An extension patterned after the Ethernet system may be used in the future to obtain a higher data rate for those users who require this capability. 6 figures.

33567 (SAND—76-0448) **Ridge regression.** Iman, R.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract EY-76-C-04-0789. 33p. Dep. NTIS $4.00.

Ridge Regression is a description of a new multiple regression program. This program provides for a backward solution to multiple regression problems and will give the ridge regression solution for the full model. This document has been designed for users of the ridge regression program.

33568 (TID—26619) **Real-time BASIC for CAMAC.** (Energy Research and Development Administration, Washington, D.C. (USA)). Feb 1977. 24p. Dep. NTIS $3.00.

This document recommends an extension to BASIC in which CAMAC is introduced as part of a general real-time scheme. The language is extended by the introduction of interrupt handling, real-time operations, and CAMAC entities in the form of process variables. The only major change to the syntax is the introduction of declaration statements to assign attributes to process variables. The extension is in keeping with the general philosophy of BASIC, and

reflects current trends in real-time language and operating system design.

33569 (TID—27375) **Summary sheets. Revision 3.** Huskamp, J.C.; Nickolas, P.; Killian, M.J.; Thompson, D.; Minton, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1976. Contract W-7405-ENG-48. 192p. Dep. NTIS $7.50.

Concise summary sheets are given as a quick reference for the utility routines available on the Octopus system at LLL. The summaries assume that the reader is at least familiar with the routine needed, so that a brief description is all that is required. The content of the publication is not exhaustive; new summary sheets will be added as additional pages. The 3½" x 6" page size fits a small notebook. (RWR)

33570 (UCID—17357) **GENVAR: a general linear computer program for model forecasting and variance analysis.** Stratton, S.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Jan 1977. Contract W-7405-ENG-48. 39p. Dep. NTIS $4.00.

This report describes GENVAR, an interactive computer program which can perform a least-squares fit to the matrix equation $\beta X = Y$, where X is a matrix of observable inputs and Y is a vector of observable outcomes for the input values. The program is controlled by teletypewriter, and is written in LRLTRAN for compilation by CHAT and execution on a CDC 7600. The report describes the way the program operates as well as ways GENVAR can be used to make statistically considered forecasts. Samples of graphic output and the source code listing (GLMVAR) are provided. 2 figures, 3 tables.

33571 (UCID—17388) **Catastrophe theory. Part I. Mathematical aspects.** Zaslawsky, E.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Oct 1976. Contract W-7405-ENG-48. 68p. Dep. NTIS $4.50.

This reasonably self-contained report on Catastrophe Theory begins with the mathematical history of Catastrophe Theory and discusses the relation between Catastrophe Theory and the "Catastrophe Theorem" presented in the report. Catastrophe Theory consists of a "local" classification theorem for unfoldings of germ singularities, which satisfy certain conditions. The "classification" is a list of seven (nonsimilar) irreducible unfoldings (and their respective germs), such that the given unfolding must be reduced with index zero to exactly one of these (or to the "constant" unfolding of the same unfolding dimension). The Catastrophe Theorem is stated (together with background definitions and commentary) and a summary of the proof of this theorem is given. 6 tables. (RWR)

33572 (UCID—30077(Rev.1)) **EISPACK: user's guide.** Dickinson, R.P. Jr.; Fritsch, F.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1976. Contract W-7405-ENG-48. 46p. Dep. NTIS $4.00.

EISPACK is a collection of subroutines, written in ANSI Standard Fortran, designed to compute the eigenvalues and eigenvectors for a variety of matrix problems. These codes form a complete eigensystem package, are representative of the state-of-the-art in speed and accuracy, and have been thoroughly tested and certified. This report is intended to simplify the task of determining which of the routines are to be used for solving the particular problem at hand. 5 tables.

33573 **MST-80 microprocessor trainer (Sep 1976) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2547/1).

15 drawings.

Parts lists and drawings are given for the MST-80, a complete, self-contained, 8-bit microcomputer system housed in a briefcase for portability and ease of use. Details are included of the chassis plate, electronic circuits, and briefcase modification. (PMA)

33574 **MST-80 microprocessor trainer (Sep 1976) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2547).

4 drawings.

Drawings are given for the MST-80, a complete, self-contained, 8-bit microcomputer system housed in a briefcase for portability and ease of use. The MST-80 utilizes the Intel 8080 microprocessor integrated circuit and associated support ICs. A keyboard ad numerical display are provided, so no external input/output device (such as a teleprinter) is required. A breadboard socket and an 8-bit input/output port is provided, however, so that external experiments may be interfaced to the system if desired. The trainer includes 1024 bytes of read/write memory and has sockets for up to 768 bytes of programmable read-only memory.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 32699

33575 (BNL—21854) **Energy Model Data Base (EMDB). Using System 2000.** Newhouse, P.H. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1976. Contract E(30-1)-16. 22p. (CONF-760989—1). Dep. NTIS $3.50.

From Association of System 2000 Users for Technical Exchange meeting; Toronto, Canada (29 Sep 1976).

The Energy Model Data Base (EMDB) at BNL is discussed. It contains high-quality, documented numeric data describing the technological processes which comprise the United States Energy System. The EMDB was designed as a collection of energy data to be used in an array of energy systems modeling tasks. The history and use of the EMDB are explained in a nontechnical way. 12 figures. (RWR)

33576 (MRR—159) **Information system for establishing reliability data for power plant components.** Wohak, B.; Meinlschmidt, G. (Technische Univ. Muenchen, Garching (Germany, F.R.). Lab. fuer Reaktorregelung und Anlagensicherung). Jun 1976. 92p. (In German). NTIS (US Sales Only) $5.50.

5 figs.; 8 refs.; with tabs.

The increasing importance of safety and availability of power plant units demands more detailed and proven reliability data for plant components than operational experience could provide till now. In the Federal Republic of Germany an extensive collection of field data from a conventional power plant has been compiled since 1972. By this report the authors present a computer-based information system for the establishment of empirically tested reliability data for power plant components.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

ERDA Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

A

Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.
Role of electron spin in the NF kinetic system. Interim report, 2:33354 (AD—A029527)

Aerospace Corp., Los Angeles, Calif. (USA)
Control of waste and water pollution from power plant flue gas cleaning systems: first annual R and D report. Annual report Jan—Dec 75, 2:32284 (PB—259 211)

AiResearch Mfg. Co. of Arizona, Phoenix (USA)
Quality assurance program supplement for ERDA—Brayton Isotope Power System (BIPS), 2:32167 (TID—27373)

Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA)
Spectroscopy of fission fragment excited atmospheric pressure argon and xenon plasmas. Doctoral dissertation, 2:32988 (AD-A—026263)

Air Force Materials Lab., Wright-Patterson AFB, Ohio (USA)
Optical properties of europium-doped potassium chloride laser window materials. Interim technical report 1 May—31 Dec 1975, 2:32989 (AD-A—026363)

Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)
Information theory analysis of deactivation rates in chemical lasers. Final report, 2:32986 (AD—A032139)

Alabama Univ., Huntsville (USA). Center for Environmental and Energy Studies
Executive summary of the National Solar Energy workshop of the ERDA Division of Solar Energy and the state energy offices, 2:32242 (TID—21337)

Alaska Univ., College (USA). Inst. of Marine Science
The arctic coastal environment of alaska. Volume I. The nearshore marine environment in Prudhoe Bay, Alaska, 2:33197 (PB—257 353)

Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Frankfurt am Main (Germany, F.R.). Bereich Forschung und Entwicklung
Studies on low temperature cable for power transmission. Final report, 2:32305 (BMFT-FB-T—76-01)

Allgemeine Elektricitaets-Gesellschaft AEG Telefunken Kabelwerke A.G., Rheydt (Germany, F.R.)
Studies on low temperature cable for power transmission. Final report, 2:32305 (BMFT-FB-T—76-01)

Ames Lab., Iowa (USA)
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Interaction of nitric oxide wth the (1010) face of ruthenium, 2:32909 (IS-T—749)
Synthesis and characterization of some reduced zirconium halides, 2:32868 (IS-T—736)

AN Armyanskoj SSR, Erevan. Inst. Fiziki
Separation of heavy ion tracks in nuclear emulsions by means of the pulsed electric field, 2:33097 (AED-Conf—76-421-001)

AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.
Power and signal-information circuits for hf plasma heating, 2:33542 (KFTI—74-44)

Argonne National Lab., Ill. (USA)
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Fatigue crack morphology in 304 stainless steel cycled at constant stress amplitude, 2:32814 (CONF-770601—1)
Status report for nonimaging collectors (compound parabolic concentrators), July 1976—January 1977, 2:32248 (ANL-SOL—77-01)
Three-dimensional thermal-neutron radiography, 2:32375 (ANL—76-113)
Transactions of the second technical exchange meeting on fuel- and clad-motion diagnostics for LMFBR safety test facilities, 2:32586 (ANL/RAS—76-34)

Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)
Multiaxial creep in concrete. Final report, 2:32872 (AD—A029815)

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Army Missile Research Development and Engineering Lab., Redstone Arsenal, Ala. (USA). Propulsion Directorate
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Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee
Control system of the Wega stellarator using a MICRAL G microcomputer, 2:33559 (EUR-CEA-FC—818)
Diffusion in tokamaks with impurities in the Pfirsch Schluter regime, 2:33535 (EUR-CEA-FC—830)
Neutral injector using an ion source at the electron cyclotron resonance, 2:33544 (EUR-CEA-FC—831)
Nonlinear evolution equations having a physical meaning, 2:33479 (EUR-CEA-FC—826)
Radiation losses from oxygen and iron impurities in a high temperature plasma, 2:33441 (EUR-CEA-FC—822)
Theoretical energy levels and wavelengths for some spectra of highly ionized molybdenum between Mo XL and Mo XXIV, 2:33350 (EUR-CEA-FC—827)

Atlantic Richfield Hanford Co., Richland, Wash. (USA)
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Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.
AECL research and development in engineering, winter 1975, 2:32498 (AECL—5310)

Atomic Energy of Canada Ltd., Ottawa, Ontario
Annual report 1975-1976, 2:33564 (AECL—5541)
Standardized CANDU 600 MWe nuclear reactor, 2:32364 (INIS-mf—3222)
Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment
Thorium cycle in heavy water moderated pressure tube (CANDU) reactors, 2:32358 (AECL—5398)

B

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Extension planning for electrical energy supply systems, 2:32456 (AED-Conf—75-769-010)
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Nuclear power investment and generating costs from a utility point of view, 2:32467 (AED-Conf—75-769-105)
Battelle Columbus Labs., Ohio (USA)
Fission product transport analysis. Quarterly progress report, July—September 1976, 2:32598 (BMI-NUREG—1965)
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Evaluating the effects of low-level chronic exposures, 2:33252 (BNWL-SA—5992)
LWR fuel recycle program quarterly progress report, October—December 1976, 2:32105 (BNWL—2080-3)
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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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2141	2:33118	Dep. NTIS, $4.00
BNWL-SA-5992	2:33252	Dep. NTIS, $3.50
BNWL-tr-227	2:32902	Dep. NTIS, $3.50
228	2:32122	Dep. NTIS, $3.50
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3498	2:32541	NTIS (US Sales Only)
3523	2:32147	TIC
3531	2:32344	INIS
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3546	2:32599	INIS
3566	2:32600	INIS
3573	2:32982	NTIS (US Sales Only)
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1886	2:32564	NTIS (US Sales Only)
1903	2:32881	NTIS (US Sales Only)
CEA-R-4765	2:32500	INIS
4769	2:32501	NTIS (US Sales Only)
CEA-S-MCH-MENT-5	2:32499	*See* CEA-N-1857(ed.2)
CEM-4162-537	2:33124	*See* PB-258 996
CONF-730497-		(All-Union seminar on problems of the control and guarantee of the purity of the atmosphere, Moscow, Union of Soviet Socialist Republics (USSR), Apr 1973)
	2:33130	Gidrometeoizdat (1975).
CONF-7310127-		(Symposium on radioiodine, Kumatori, Osaka, Japan, 24 Oct 1973)
	2:32929	*See* KURRI-TR-125
CONF-7406128-		(Institute of Gas Technology, Algiers, Algeria, 24-27 Jun 1974)
	2:31887	Institute of Gas Technology (1974). $40.00
CONF-750383-		(Seminar on measurement techniques, Prague, Czechoslovakia, 25 Mar 1975)
	2:32413	*See* UJV-mf-1
	2:32414	*See* UJV-mf-1
CONF-750781-		(Laser fusion workshop, Daisen, Tottori, Japan, 16 Jul 1975)
	2:33550	*See* IPPJ-235
CONF-7509129-		(Meeting on nuclear power plant project planning and implementation, Karlsruhe, German, Federal Republic of (F.R. Germany), 17 Sep 1975)
120	2:32309	*See* AED-CONF-75-769-050
121	2:32310	*See* AED-Conf-75-769-102
122	2:32461	*See* AED-Conf-75-769-061
123	2:32463	*See* AED-Conf-75-769-078
124	2:32456	*See* AED-Conf-75-769-010
125	2:32457	*See* AED-Conf-75-769-012
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127	2:32459	*See* AED-Conf-75-769-023
128	2:32460	*See* AED-Conf-75-769-028
129	2:32462	*See* AED-Conf-75-769-076
130	2:32464	*See* AED-Conf-75-769-079
131	2:32465	*See* AED-Conf-75-769-092
132	2:32466	*See* AED-Conf-75-769-098
133	2:32467	*See* AED-Conf-75-769-105
134	2:32468	*See* AED-Conf-75-769-125
135	2:32469	*See* AED-Conf-75-769-126
136	2:32482	*See* AED-Conf-75-769-081
137	2:32481	*See* AED-Conf-75-769-080
140	2:32581	*See* AED-Conf-75-769-062
CONF-751093-		(Symposium on progress in nuclear technique and applications in science and industry, Zakopane, Poland, 21-25 Oct 1975)
P7	2:32896	*See* INT-92/I
CONF-7510143-		(Cycle of lectures on the cold sources of electric power plants, Royaumont, France, 6 Oct 1975)
15	2:32276	*See* FRNC-CONF-147
16	2:32503	*See* FRNC-CONF-156
17	2:32277	*See* FRNC-CONF-153
18	2:32504	*See* FRNC-CONF-160
19	2:32280	*See* FRNC-CONF-151
CONF-7510152-		(CRYO/'75 conference, Los Angeles, California, United States of America (USA), 16 Oct 1975)
1	2:31912	Institute of Gas Technology, Chicago, IL
CONF-751141-		(Meeting on fuel and clad motion diagnostics in LMFBR safety test facilities, Albuquerque, New Mexico, USA, 11-13 Nov 1975)
	2:32636	*See* SAND-76-5547
CONF-7511123-		(Technical meeting of the Fachgruppe Brennelemente of the KTG, Erlangen, German, Federal Republic of (F.R. Germany), 14 Nov 1975)
	2:32582	*See* AED-Conf-75-773-000
CONF-751257-		(2. international conference on electrical safety in hazardous environments, London, United Kingdom of Great Britain and Northern Ireland (UK), 9-11 Dec 1975)
	2:31852	10.00 pou
CONF-760245-		(Symposium on systems analysis and energy policy, Baden-Wurttemberg Stuttgart, German, Federal Republic of (F.R. Germany), 11 Feb 1976)
	2:32736	*See* KFK-EXT-2/76-1
CONF-760306-		(SPIE/SPSE technical symposium, Reston, Virginia, United States of America (USA), 22-23 Mar 1976)
P2	2:32994	Society of Photo-Optical Instrumentation Engineers (1976).
CONF-760381-		(Conference on nuclear energy and America's energy needs, Washington, District of Columbia, United States of America (USA), 18-19 Mar 1976)
	2:32722	Industrial Union Dept., AFL-CIO, 815 16th St., NW, Washington, DC
CONF-760386-		(Meeting on nuclear power plant control, Saclay, France, 8 Mar 1976)
2	2:32541	*See* CEA-CONF-3498

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CONF-760447-		(Conference of the Division of Environmental Chemistry, of the American Chemical Society, New York, New York, United States of America (USA), 4-9 Apr 1976)
P1	2:33150	Carnegie-Mellon Institute of Research, $5.00
CONF-760498-		(51. International School of Hydrocarbon Measurement conference, Norman, Oklahoma, United States of America (USA), 13-15 Apr 1976)
	2:31889	University of Oklahoma (1976).
CONF-760577-		(Offshore technology conference, Houston, Texas, United States of America (USA), 3-6 May 1976)
P1	2:31791	Offshore Technology Conference (1976).
P2	2:31790	Offshore Technology Conference (1976).
CONF-760676-		(CIM/CSPG convention on enhanced recovery, Calgary, Canada, 7-11 Jun 1976)
	2:31819	Gulf Oil Canada Ltd. (1976). $20.00
CONF-760942-		(Conference on proton linear accelerator, Ontario, Canada, 14-17 Sep 1976)
27	2:33095	*See* SLAC-PUB-1815
CONF-760964-		(9. international conference on solid state nuclear track detectors, Neuherberg/ Munchen, German, Federal Republic of (F.R. Germany), 30 Sep-6 Oct 1976)
10	2:33097	*See* AED-Conf-76-421-001
CONF-760989-		(Association of System 2000 Users for Technical Exchange meeting, Toronto, Canada, 29 Sep-1 Oct 1976)
1	2:33575	*See* BNL-21854
CONF-760995-		(40. physicists' meeting, Bonn, German, Federal Republic of (F.R. Germany), 14 Sep 1976)
2	2:33548	*See* AED-Conf-76-379-002
CONF-7609109-		(Safety technology meeting on inherent retention, Bethesda, Maryland, United States of America (USA), Sep 1976)
1	2:32604	*See* HEDL-SA-1119-FP
CONF-7609112-		(Euromech-colloquium-80 on separation phenomena in gas mixture flows, Karlsruhe, German, Federal Republic of (F.R. Germany), 6 Sep 1976)
1	2:32081	*See* AED-Conf-76-481-003
2	2:32082	*See* AED-Conf-76-481-004
4	2:32080	*See* AED-Conf-76-481-002
CONF-7609113-		(Congress on rational energy utilities in urban systems with specialized exhibition at the German Industrial Exhibition, Berlin, German, Federal Republic of (F.R. Germany), 18 Sep 1976)
1	2:32342	*See* AED-Conf-76-407-011
CONF-761022-		(Fuel and clad motion diagnostics for LMFBR safety test facilities conference, Chicago, Illinois, United States of America (USA), 9 Oct 1976)
	2:32586	*See* ANL/RAS-76-34
CONF-761023-		(2. ERDA statistical symposium, Oak Ridge, Tennessee, United States of America (USA), 25-27 Oct 1976)
4	2:33252	*See* BNWL-SA-5992
CONF-761107-		(Annual meeting of the American Society of Mechanical Engineers, New York, New York, United States of America (USA), 29 Nov-5 Dec 1976)
24	2:32938	*See* Y/PK-580
CONF-761132-		(Workshop on separation of normal and neoplastic cells, Amsterdam, Netherlands, 9-11 Nov 1976)
1	2:33223	*See* LA-UR-76-2462
CONF-761135-		(American Chemical Society Pacific conference, Phoenix, Arizona, United States of America (USA), 7-10 Nov 1976)
2	2:32566	*See* HEDL-SA-806FP
CONF-770107-		(Information meeting on acceleration breeding, Upton, New York, United States of America (USA), 18-19 Jan 1977)
1	2:33092	*See* UCRL-79151
CONF-770303-		(Corrosion/77 NACE meeting, San Francisco, California, United States of America (USA), 14-18 Mar 1977)
8	2:32910	*See* LA-UR-76-2500
CONF-770601-		(4. international conference on fracture, Waterloo, Canada, 19-24 Jun 1977)
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9	2:33099	*See* GSI-M-3-76
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